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**16. Abstracts** - A report is presented which is directed to the definition and analyses of governmental approaches to control air pollution from privately owned automobiles. The report is separated into three basic components; 1. average emission per vehicle per mile; 2. miles of use and 3. location of use. Chapter 1 discusses policies aimed at the automotive industries to encourage development of pollution control technology and low pollution fuels. Correspondingly, the range of policies available to induce the motorist to do his part to control average emissions per mile are discussed in Chapter 2. Chapter 3 considers the measures available to reduce the aggregate amount of annual automobile use. Chapter 4 details what urban planners can do to reduce auto pollution emissions in urban areas and facilitate dispersion of existing pollution. The two remaining chapters deal with the relations among these focal points.

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# GOVERNMENTAL APPROACHES TO AUTOMOBILE AIR POLLUTION CONTROL

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Coordinator

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LYLE C. FITCH, PRESIDENT

August 1, 1971

Mr. Paul Gerhardt, Chief Economist
Office of Program Development
Office of Air Programs
Environmental Protection Agency
5600 Fisher's Lane
Rockville, Maryland 20850

Dear Mr. Gerhardt:

I am pleased to transmit the attached report Governmental Approaches to Automobile Air Pollution Control by the Institute of Public Administration. This report is the companion volume to Governmental Approaches to Air Pollution Control: A Draft Comdium and Annotated Bibliography submitted to your office on July 15, 1971. The subject of automobile air pollution is so important and the scope of investigation so wide, that it was decided to compile a separate study rather than attempt to include this material in the final report. In addition to bringing together in one place the full range of governmental approaches for dealing with automobile air pollution, we have attempted to place these approaches in an analytic framework which facilitates both the comparison of existing approaches and the discovery of new policy possibilities.

We should like to express our appreciation to those staff members of the Office of Air Programs and the Bureau of Mobile Sources who commented on the draft version of this volume in April. Their suggestions have been incorporated in the appropriate sections. In addition, since events in this field are following upon one another so rapidly, a section (Appendix C) has been added to record the most recent developments of significance that have occurred since the initial draft of this report was submitted on March 1, 1971.

Sincerely,

Sumner Myers

Sumner Myers
Project Director

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# INTRODUCTION

This report, prepared under the direction of the Institute for Public Adminstration (IPA), contains findings of research carried out for the Office of Air Programs (OAP) of the Environmental Protection Agency under Contract No. EHS 70-126. The general purpose of this research, as described in the contract, is "to identify and evaluate alternative Federal strategies to improve and develop inducements for control of air pollution by the private sector." The initial research under this agreement is now included in the IPA document entitled, "Governmental Approaches to Air Pollution Control: A Compendium and Annotated Bibliography." This work discusses mechanisms of government control of air pollution from stationary sources only. However, in view of the significant air pollution problem caused by mobile sources, it was felt that additional research on mobile source air pollution was worthwhile. Furthermore, it was felt that limiting the scope of this additional research to automobiles would permit a more comprehensive analysis than would otherwise be possible under the circumstances. Since automobiles contribute nearly 90 percent of the pollution (by weight) from all mobile sources, this focus would direct the research efforts to what is clearly the most critical area in the control of air pollution from mobile sources. Accordingly, this report is directed entirely to the definition and analyses of governmental approaches to control air pollution from privately owned automobiles.[1]

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[1] Although most of the discussion in this report applies to commercially owned and operated automobiles as well, such vehicles are not given explicit consideration.

## Purpose

The purpose of Governmental Approaches to Automobile Air Pollution Control is (1) to bring together in one place the full range of policy approaches affecting automobile pollution control and, (2) to place them in an analytical framework which facilitates both the comparison of existing policies and the discovery of new policy possibilities. Accordingly, this report comprehends more than a discussion of those policies now in practice or currently under consideration in government circles. For example, policies are analyzed for which the necessary technology may not be immediately available or for which rather complicated, expensive and intrusive administration would be required (such as emission charge systems using sophisticated monitoring equipment). Though the report frequently will indicate problem areas with individual control approaches, there will be little attempt to weigh the advantages and disadvantages of some policies against others. Firm conclusions can only be reached by additional research to determine the precise costs and air pollution reductions possible using the approaches detailed in this report.

## Organization

The analytical framework created for this report separates auto air pollution damage[1] into three basic components, any of which are subject to government action:

---

[1] "Damage" as used in this report, refers in a general fashion to the injury to people, buildings, vegetation, etc., by air pollution. Using this definition, the extent of auto-related air pollution damage is a function both of the magnitude of the emissions, and the location in which these emissions take place.

1. Average emission per vehicle per mile
2. Miles of use
3. Location of use

Public policies which depend solely on control of any one variable can, at best, achieve only partial success since the resulting gain in air quality could be completely overwhelmed by changes in the other two variables. Hence, if public control policy is to guarantee a reduction in the social cost of air pollution, it must manipulate or control all three variables.[1]

The separation of pollution damage into the components outlined above, has many advantages. Since the current federal strategy has been centered largely around control of one of these components -- average emissions per vehicle per mile -- this framework will facilitate the development of supplementary and complementary policies to insure effective control of auto air pollution and to minimize the costs of doing so. This separation also will allow detailed analysis of the broad range of possible actions on the basis of what action can best influence each component, and who (manufacturers, consumers, government) can best perform the action. Furthermore, this framework will facilitate comparison of policy possibilities, since each policy can be measured against the component of pollution damage that it is designed to influence. For example, both state emission checking programs and mandatory purchase of used car control devices are measures which can influence motorists' control of average emissions per mile. As indicated below, a cost-benefit analysis might conclude that only the latter policy is needed by most states to secure effective control over this component of pollution damage.

---

[1] This assumes average emissions per mile from new motor vehicles will not be reduced to a negligible amount, that is, a nearly pollution-free car will not be developed in the near future, or such complete control over the source would impose too great a cost on society. These considerations will be discussed in detail in Chapter 6.

Since the three components of auto pollution damage will provide the overall organization of this report, it is useful to understand some basic relations among them. First, emission per mile and miles of use determine the aggregate magnitude of auto air pollution, while the location -- and thus concentration -- of this amount of pollution is an essential determinant of the actual damage produced. Assuming an overall objective of reducing pollution damage, public policy should be sensitive to locational variables in addition to total emission variables.

Second, some components are far more susceptible to influence by a particular entity than others. For example, the individual motorist can exert considerable influence over the location and miles of use, but to a much smaller extent over the emissions per vehicle per mile. Though he can affect this variable through selective equipment purchase and careful maintenance, he depends largely on the technological alternatives placed upon the markets by automotive industries. Similarly, automobile use is subject to the desires of individual motorists, but the need for such transportation is determined largely by the spatial relation of people and activities. Thus, urban planners to a greater extent than motorists, can influence the number of annual miles of automobile use. These considerations suggest three basic policy targets for government, programs directed toward producers, programs directed toward consumers, and programs directed toward environmental modifications:

| Measures Directed at Automotive Industries | Measures Directed at Motor Vehicle Ownership and Use | Measures Directed at Changing the Environment |
|---|---|---|
| *Industry control of emissions per vehicle per mile | *Consumer control of emissions per vehicle per mile<br>*Control of miles of use<br>*Control of location of use | *Control of miles of use<br>*Control of Location of use |

Table 1 shows the components of auto pollution damage and the major control options available under each.

It is exactly this organizational skeleton which structures the body of this report. Chapter 1 will discuss policies aimed at the automotive industries to encourage development of pollution control technology and low pollution fuels. Correspondingly, the range of policies available to induce the motorist to do his part to control average emissions per mile will be discussed in Chapter 2. Chapter 3 will consider the measures available to reduce the aggregate amount of annual automobile use, especially in critical locations. Chapter 4 will detail what urban planners can do to reduce auto pollution emissions in urban areas and facilitate dispersion of existing pollution.

The remaining chapters will deal with the relations among these focal points. Chapter 5 will consider some emission charge systems, that is, policies which control more than one of the previous

## TABLE I

## CLASSIFICATION OF PUBLIC POLICY APPROACHES BY COMPONENTS OF AUTOMOTIVE POLLUTION DAMAGE

| AVERAGE EMISSIONS PER VEHICLE PER MILE | | MILES DRIVEN PER YEAR | LOCATION |
|---|---|---|---|
| Policies Aimed at Industry | Policies Aimed at Motorists | | |
| 1. Encouraging Development of Control Technology for pre-1968 Internal Combustion Engine Cars | 1. Mandatory maintenance requirement | 1. Discouraging private automobile use<br>a) fuel or mileage rationing<br>b) parking restrictions<br>c) preferential lanes<br>d) tax on gasoline<br>e) parking taxes<br>f) commutation taxes<br>g) tax rebates | 1. Increase average vehicle speed<br>a) expressways<br>b) traffic control<br>c) separating rights-of-way<br>d) staggering work<br>e) traffic bans |
| 2. Encouraging Development of Control Technology for New Internal Combustion Engine cars.<br>a) emission standards<br>b) emission charges<br>c) research and development grants<br>d) litigation | 2. Mandatory retrofit equipment installation requirement | 2. Total ban | 2. Facilitate dispersal<br>a) alternate land plans and urban configurations<br>b) highway design & location<br>c) alteration of traffic patterns |
| 3. Encouraging Development of Unconventional Vehicles<br>a) emission standards<br>b) ban on internal combustion engine<br>c) research and development grants<br>d) legislatively guaranteed market | 3. Used-car emission standards | 3. Mass transit<br>a) rail<br>b) bus<br>c) new designs | |
| 4. Encouraging Development of Low Polluting Fuels | 4. Discriminatory licensing fee based on emissions of vehicle | 4. Urban design<br>a) reduce average trip length<br>b) make economical, convenient mass transit possible | |
| | 5. Discriminatory sales tax based on emissions of vehicle | | |

variables through a price on emissions. The final chapter, Chapter 6, will analyze some of the important considerations related to combining the materials in the previous chapters into an effective federal strategy for the control of auto-related air pollution. In addition, Appendix A will give an overview of major federal legislation related to the auto air pollution problem, Appendix B will summarize federal emission standards, and Appendix C will highlight recent developments in the area of automobile air pollution control which have occurred since this report was originally submitted on April 1, 1971.

It is important for those with a national policy orientation to realize that not all of the policy alternatives available in Chapters 2, 3, and 4 will necessarily be available at the federal level. For example, discriminatory licensing taxes for automobiles with relatively high emissions per mile (Chapter 2) will probably lie within the domain of state authority. However, policy alternatives at lower levels of government will often suggest federal counterparts (in this case, federal discriminatory excise taxes) or suggest the desirability of federal action to induce states or localities to take certain actions. In any event, the options open to state and local governments as well as the aggressiveness with which they are exercised can have strong bearing on the nature of the federal role. A comprehensive and organized review of policy alternatives available at all levels of government will also place the role of the Federal Government in perspective.

# CHAPTER 1

## INDUSTRY CONTROL OF AVERAGE EMISSIONS PER MILE

Control over the emissions source, the engine-fuel systems, is the most direct approach to reducing auto air pollution. It is the mainstay of current federal auto pollution control policy and, if totally successful, could conceivably end the automotive air pollution problem. It is more likely, however, that considerations of cost and equity -- as reflected in the range of technological possibilities -- will require control of the source be supplemented by other policies.[1]

The focus of this chapter is on programs designed to stimulate automobile manufacturers, fuel producers and other related industries to develop the technology necessary for effective control of pollutant emission per mile of automobile usage. More specifically this focus implies an evaluation of the relative costs and benefits of government action in three basic areas:

1) Development of control technology for the internal combustion engine.

2) Development of unconventional engines having low pollution emission.

3) Development of low pollution fuels.

With respect to the first two areas, the chapter will evaluate the role of direct regulation, economic incentives, and litigation. In addition to encouraging development of pollution control systems for new vehicles, consideration will be given to government's role in the development of new devices for older automobiles with no pollution control systems.[1] And, since, control of the source is the major federal strategy, current federal programs will be discussed and some basic information necessary to understand the auto air pollution problem will be briefly outlined.

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[1] This assumption will be examined in detail in Chapter 6.

## Encouraging Control Technology

### Pre-1968 Automobiles.

Currently, approximately 70 percent of the nation's automobiles (pre-1968) do not have any type of pollution control device or system. Depending upon age and degree of maintenance, these vehicles emit anything from five to one hundred times as much pollution as new models. These pre-controlled vehicles are being phased out of use at a rate of approximately 10 percent per year, which means they will contribute significantly to automobile-caused pollution for the next few years unless control devices are developed and applied.

Research efforts conducted by the auto manufacturers as well as several other firms have resulted in a number of low cost

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1. Although development of new control technology, new engines and new fuels can make the greatest impact on average emissions per mile, there are other ways in which such control can be achieved. Motorists, for example, could keep their vehicles well maintained and purchase existing control equipment if their vehicles do not have a control system. In addition, measures designed to increase average vehicle speed will reduce emissions per mile. However, these alternatives relate to vehicle ownership and usage behavior. Since this chapter will be devoted to public policies aimed at industry, these alternatives will be discussed in Chapters 2 and 4, respectively.

devices which are compatible for most pre-1968 cars. A typical device, General Motors' "used-car kit", costs approximately $50 including installation, and (according to the manufacturer's specifications) will reduce hydrocarbon emissions by 52 percent, carbon monoxide emissions by 37 percent and nitrogen oxide emissions by 31 percent.[1]

Thus, the problem with control technology for used cars is not development, but application. However, development of more sophisticated devices could influence consumer acceptability.[2] Furthermore, the Federal Government by establishing a certification program could protect consumers from fraud and insure that the devices marketed were effective and durable. A precendent for federal certification can be found in California. This state certifies (and requires installation of) used car control devices that meet certain cost and emission reduction criteria. (See p. 2-8.)

One way to secure widespread application would be to impose a retroactive installation obligation on automobile manufacturers.

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1. General Motors Corporation, "The General Motors Used Car Emission Control," December 1969.

2. A report from one manufacturer indicated that of 59 cars equipped with the device, 12 were made less driveable by the installation of the kit and 35 cars remained unchanged. The General Motors Used Car Emission Control, General Motors Corporation, December 1969. The adverse effects of current devices include rough operation at low speed ranges, rough idling speed, and an increase in creep speed.

This measure was considered recently in proposed legislation.[1] However, such a policy would be extremely costly to the auto manufacturers and apparently can be justified only as a punitive measure. Relief of this nature is being sought in numerous law suits that are now pending (see "Legal Approaches" below).

Other measures would include direct regulation requiring motorists with pre-1968 cars to purchase control devices or a financial incentive. These will be discussed in the following chapter insofar as they relate to policy alternatives directed at individual motorists.

New Internal Combustion Engine Automobiles[2]

Action by the Federal Government appears to be needed to provide the incentives for development of auto pollution control technology by the private sector.[3] In a strictly commercial sense, the development of pollution control equipment is simply not good business:

---

[1] See The National Air Quality Standards Act of 1970, Report of the Committee on Public Works, United States Senate, Serial No. 91-1196 (September 17, 1970), p. 13.

[2] Various technological alternatives for controlling automotive emissions are being pursued. "Add-on" devices include catalytic convertors, manifold reactors, and direct flame afterburners. Other possibilities include engine refinements and exhaust gas recirculation. For a comprehensive review, including cost and performance estimates, see Control Techniques for Carbon Monoxide, Nitrogen Oxide, and Hydrocarbon Emissions from Mobile Sources; National Air Pollution Control Administration, March 1970.

[3] For evidence of the reluctance of the auto industry to take the initiative in developing pollution control technology, see John C. Esposito, Vanishing Air (New York: Grossman, 1970), Chapter 2.

> Control of air pollution does not make cars easier to sell, it does not make them cheaper to produce, and it does not reduce comebacks on the warranty. To people interested in profits, expenses for the development and production of exhaust controls are liabilities.[1]

Manufacturers are particularly concerned about the price increase that would result from the introduction of pollution control technology:

> . . . a lot of our customers couldn't and wouldn't go along. Some of them would have to buy down to less car than they really want. Some would have to do without or settle for used cars. And recent experience indicates a lot of them would join the ranks of import buyers.[2]

In the absence of Governmental pressure, these considerations show why it is unlikely that the auto industry would act to control air pollution.

## Standards for New Vehicles

One way to control the source is to set maximum limits on emissions from new motor vehicles; this has been the core of the federal strategy to encourage auto manufacturers to develop and apply emission control technologies.[1] The summary of federal auto air pollution legislation in Appendix A highlights the emphasis on emission standards, and more generally, control of the source.

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[1] S. Smith Griswold, cited in "The Way Detroit Wages War on Pollution", by Coleman McCarthy, The Washington Post, January 26, 1970. Smith Griswold has held executive positions with the California Air Resources Board and more recently with the National Air Pollution Control Administration.

[2] Lee A. Iococca, President of the Ford Motor Company cited in "Environment Mortgaged to Buy Life's Frills" by Milton Viorst, The Evening Star, November 10, 1970, p. A-21. As Viorst pointed out, Iococca is really saying that the country will have to accept a decline in its material standard of living if it is serious about restoring the environment. Unfortunately for the automakers, car purchases will reflect strongly this reduced material standard of living.

Standard setting. Under the authority granted in the Motor Vehicle Air Pollution Control Act,[2] the Secretary of the Department of Health, Education, and Welfare[3] may regulate the discharge of any substances from new motor vehicles.[4] The federal standards promulgated to date as well as the proposed HEW standards are summarized in Appendix B. The impact of present and future standards on automobile emission levels is also shown.

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[1] Unlike the Congressional legislation concerning stationary source air pollution (which places the responsibility on the states), the authority for setting mobile source standards has been pre-empted by the Federal Government. Nationwide standards for automobiles are considered vital since autos are designed, manufactured, and distributed on a national basis and move frequently over state lines. California, however, has been granted permission to set standards more stringent than national standards because of the severe air pollution problems in that state. See Clean Air Act Amendments of 1965, P.L. 89-272, Sec. 208.

[2] Title II of the Clean Air Act Amendments of 1965, P.L. 89-272.

[3] A recent reorganization of the federal pollution control efforts places responsibility for air pollution control in the Office of Air Programs (OAP) of the newly-created Environmental Protection Agency (EPA). Formerly, this responsibility was mandated to EPA's Air Pollution Control Office (APCO) and prior to that the National Air Pollution Control Administration (NAPCA), an entity in the Department of Health, Education, and Welfare (HEW). Hence, although references here to past legislation or historical events will often refer to APCO, NAPCA or the Secretary of HEW, it should be understood that the responsibility for air pollution control now resides with OAP and the Administrator of EPA.

[4] The primary pollutants emitted by the internal combustion engine are carbon monoxide, hydrocarbons, nitrogen oxides, and lead. Increased concern is currently being voiced over the emissions of rubber and asbestos particles (from brake linings and clutch facings) but no federal regulatory action is currently programmed.

Congress has departed from the previous executive standard setting procedure and written explicit standards for 1975-76 into federal law. The new legislation, 1970 Amendments to the Clean Air Act,[1] provides for a 90 percent reduction in levels of automobile emissions as compared to the 1970 model year levels. (See Appendix B for details.)

The automobile industry strongly opposed Congressional standard setting:

> . . . we believe it is completely unrealistic to freeze standards into the Statute. By doing so, it deprives the Secretary /Administrator/ of the opportunity to set standards based on the national air ambient quality standards which this bill directs him to promulgate. With new data being accumulated daily this can be accomplished by a responsive technical administrative agency and not frozen arbitrarily into law with no scientific justification for the levels of control specified. We submit that these laws must provide for some flexibility.[2]

The extensive legislative hearings held by both Houses of Congress in 1970 highlighted the urgency of the auto air pollution problem. Upon learning that the level of ambient air quality necessary to protect the public's health would not be reached before 1990 under the existing HEW standards schedule, Congress felt such a strong measure was warranted. This conclusion was based on federally established air quality criteria and auto emission research which together indicated that the 1980 research goals proposed by HEW were vital for health reasons, and an estimate of ten years for sufficient replacement of automobiles with those having the emission controls meeting 1980 standards.[1] The establishment of emission standards on the sole basis of perceived public health and welfare needs represents a substantial departure from previous legislation which required "appropriate consideration of technological feasibility and economic costs."[2]

---

[1] The 1970 Amendments to the Clean Air Act were reported by a House-Senate Conference Committee on December 16, 1970, and signed into law on December 31, 1970, P.L. 91-604.

[2] Information submitted to the Senate Subcommittee on Air and Water Pollution by Ford Motor Company. Reprinted in Hearings before the Subcommittee on Air and Water Pollution, United States Senate, 91st Congress (1970), Part 5, p. 1605.

Rationale for standards. Prior to the establishment of standards on the basis of an investigation of air pollution effects (i.e., air quality criteria documents), standards were (and to some extent still are) essentially ultimatums designed to goad the auto industry into commercial application of successively greater degrees of control technology at the earliest possible times. Underlying the standards approach have been two premises -- either the industry is deliberately witholding available pollution controls, or a stringent set of standards can be the "mother of invention." As will be discussed below, the first premise seems unlikely but there is evidence which indicates that the second may well be true.

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1. For a brief derivation of the new standards, see National Air Quality Standards Act of 1970 /Senate version of Clean Air Act Amendments of 1970/; Report of the Committee on Public Works, United States Senate, Serial No. 91-1196, September 17, 1970, pp. 25-27.

2. Air Quality Act of 1967, P.L. 90-148, Sec. 202(a).

In support of the first premise, a number of law suits have been brought which allege that from the mid-1950's until fairly recently, the automakers have conspired to prevent the development and installation of anti-smog devices. The Federal Government charged the auto companies with such conspiracy and recently settled the case by consent decree.[1] A number of cities and states filed similar suits which are currently pending in the courts (see "Legal Approaches" below). Further supporting this view, a former federal pollution abatement official stated in 1964 that he felt the automobile manufacturers had deliberately withheld existing control technology. "Everything that the industry has disclosed that it is able to do today in 1964 to control auto exhaust, was possible technically ten years ago. No new principles had to be developed, no technological advance was needed, no scientific breakthrough was required."[2]

Today, however, there can be little question that the technology to meet the proposed standards does not currently exist, that the accelerated demands for cleaner engines will require advances and technological breakthroughs. The guidelines agreed to by the auto industry in settlement of the Federal Government's antitrust suit and the increased scrutiny of the industry by both government and the public also reduce the possibility that the automakers may be guilty of suppressing available technology.

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[1] Although by entering the consent decree, the auto companies do not admit guilt, one outspoken critic of the industry believes that the Government's allegations "should stand as a reminder of the vast potential for members of this industry to agree to do nothing." Ralph Nader cited in Ideas (Washington, D.C.: International Research and Technology, December 1969), p. 115.

[2] S. Smith Griswold cited in "The Way Detroit Wages War on Pollution" by Coleman McCarthy, The Washington Post, January 26, 1970. The controls cited were required in California cars in 1964 and nationwide in 1968.

The other underlying premise of the standards approach is essentially that the Federal Government can "legislate technology." Although the behavior of the auto industry in the past would suggest a lack of serious commitment to pollution control, industry representatives are increasingly vocal about their firms' commitment to clean air. They argue that immense resources are dedicated to controlling pollution and deny that any legislative pressure could result in speedier compliance with clean air needs.[1]

However, such a message has an all-too-familiar ring to critics of the auto industry. They point to 1964, when enforcement of the law in California threatened the auto industry it caused "remarkable 'technological breakthroughs'":

> During the early sixties, California enacted a statute which required that all new cars sold in that state would be equipped with controls two years after state officials certified two workable pollution-control devices. In March

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[1] A recent statement by the head of Ford Motor Company's automotive emissions office is typical of the industry's position, "We've got more than 200 engineers working three shifts a day, seven days a week on the problem. We just can't go any faster than that. We're just as concerned as anyone else." "Automotive News", February 2, 1970. Cited in Ideas (Washington, D.C.: International Research and Technology; March, 1970), p. 29. A somewhat stronger statement was made by Edward Cole, president of General Motors" . . . pollution problems cannot be legislated out of existence any more than the laws of nature can be overruled." In "Auto Industry Opens Counterattack on Environmental and Consumer Movement" by Jerry M. Flint, *The New York Times*, November 18, 1970, p. C-29.

> of 1964, the trade association which speaks for the American manufacturers forcefully reiterated its then familiar litany that no controls would be possible before the 1967 model year. But three months later, the state certified four control devices, all developed by outsiders. The prospect of having to purchase equipment from outside of the automotive establishment fired the industry's creative urge. /Chrysler quickly developed a "Clean Air Package" which was essentially copied by the other "Big Four" auto manufacturers./ The California incident illustrates graphically that volunteerism will not work with the auto industry. Only the threat of a hard and fast legal deadline succeeded. . .[1]

On the basis of such evidence, it does appear that standards through the establishment of legal deadlines can substantially motivate the industry.

## Advantages of Standards

Standards for new cars can yield significant reductions in average emissions per mile in a short time. Since the establishment of the first set of standards in 1968, 69 percent control over hydrocarbon emissions and 60 percent control over carbon monoxide emissions have been achieved.[2] This is not to say further reductions will be possible with the same speed (see "Feasibility" below), but rather that standards by explicit threat can motivate rapid compliance.

Standards are relatively easy and inexpensive to enforce. As discussed below, the national enforcement program need only sample a fraction of the auto industry's output to get a reliable measure of conformance. The small number of auto manufacturers also facilitates administration.

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[1] ". . . And a Rebuttal on Three Essential Points /to a statement made by L. A. Iococca, president of the Ford Motor Company/ " by John C. Esposito, The Washington Post, November 23, 1970, p. A-16.

[2] Source: APCO. Cited in Environmental Quality, First Annual Report of the Council on Environmental Quality; transmitted to Congress August 1970, p. 77.

## Problems with Standards

Feasibility. As discussed above, the Clean Air Act Amendments of 1970 establish a new criterion for standard setting -- the degree of control required for public health and welfare. However, a later amendment giving an additional year to automakers to meet the nitrogen oxide standards, as well as a provision for a one-year waiver of the standards upon demonstration of technological difficulties, indicate the Congress is still very much concerned about the ability of the automakers to develop the technology in the time allowed.

This highlights a basic difficulty with the standards approach: there can be no advance assurance that any particular set of standards can be met in the time required by the implementation schedule, even if automakers were totally committed to the development of pollution control technology. Neither the "ultimate" limits of the internal combustion engine nor the technologies needed to achieve it are currently known. Thus, contentions by the auto industry that they will be unable to meet the proposed standards are extremely difficult to evaluate, let alone challenge, especially since the industry controls the dominant share of the nation's automotive research and development resources.[1]

Arbitrariness. Determining specific standards to be implemented at a specific time is a task fraught with great controversy. The Air Quality Act of 1967 required the Secretary of HEW to determine air quality criteria with respect to potentially dangerous pollutants. Such research has been conducted for all automobile-related air pollutants. Although these criteria have not been universally accepted, they were crucial inputs in the recent Congressional decision to establish legislative standards.[2] Yet, even if the published air quality criteria were universally accepted, the implications of such ambient air level criteria for auto emission control would be highly disputable; the absence of reliable micro-meteorological knowledge about how pollutant gases combine and diffuse over time make it impossible to relate accurately exhaust emission concentrations to concentrations in the air.[3]

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[1] To provide policy makers with an independent source of information, the Clean Air Amendments of 1970 require the Environmental Protection Agency to arrange for a comprehensive study on the technological feasibility of meeting standards. The National Academy of Sciences will conduct this study. P. L. 91-606, Sec. 202(c)(1).

[2] See National Air Quality Standards Act of 1970, Report of the Committee on Public Works, United States Senate, September 17, 1970, p. 25.

[3] The Automobile Manufacturers Association took strong exception to the particular research document relied upon to relate air quality criteria to specific auto emission standards. (D.S. Barth, et al., "Federal Motor Vehicle Emission Goals for CO, HC, and NO. Based on Desired Air Quality Levels", a NAPCA paper presented to the annual meeting of the Air Pollution Control Association, June 1970.) In a

The inability to rationalize standards on the basis on precisely determined scientific evidence that would relate public health and welfare needs to auto emission levels has resulted in a long-standing dispute between Federal policy makers and representatives of the auto industry.[1]

Lacking defensible grounds for determination of auto emission levels, anything short of reducing such emissions to zero can be considered an arbitrary compromise. Henry Ford II recently criticized

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letter to the Secretary of HEW (August 27, 1970), the AMA claimed, "It was made manifestly clear in the paper that the measurements, math models, data analysis and conclusions are of a developmental or a preliminary nature and not intended to be construed as final or adequate for establishing legal standards." In reply, the Secretary contended that "It appears to me that the paper makes responsible and constructive use of such data and methods as a means of determining what the Nation must do in order to reduce the threat of air pollution in years to come, particularly in view of the alternative which is to postpone making projections and decisions for several years in order to produce more definitive data from which more precise conclusions could be drawn." Letters reprinted in Senate Subcommittee on Air and Water Pollution Hearings, 91st Congress, Second Session, Appendix, pp. 1576, 1596.

1. The following comments by auto industry spokesmen are representative of the current industry disagreement with both the air quality requirements and the technological capability implied in the proposed Congressional standards. ". . . our citizens have been needlessly frightened /by pollution scares/ . . . frantic measures to overcontrol automotive emissions cannot be justified during most of this decade." Charles Heinen, Chrysler Corporation's chief emissions expert. "We have an obligation to oppose technically unsound standards which impose unnecessary cost burdens on the public with no appreciable benefits in terms of air quality . . . There are limits to what can be accomplished in terms of current technology and the practical realities of the mass production system." Edward N. Cole, president of General Motors. Both in "Auto Industry Opens Counter Attack on Environmental and Consumer Movement" by Jerry M. Flint, The New York Times, November 18, 1970, p. C-29.

federal policy makers for using a moralistic approach to the pollution issue:

> One of the troubles with the moralistic approach to problems is that it doesn't lend itself to rational solutions. If something is identified as a sin, like vehicle air pollution, then obviously it should be stopped 100 per cent right now . . . If you have to compromise with sin, you might as well compromise on a nice round number like 90 per cent on some nice round date like January 1, 1975. . . . After all, if air pollution is a moral issue, not a practical one, then there's no need to consider what's necessary, what's possible, how soon it's possible, or how the benefits compare with the costs. One arbitrary compromise is as good as another. . .[1] (emphasis supplied)

Aggravating the difficulty in setting non-arbitrary standards, public pressure is making it increasingly difficult for federal policy makers to objectively evaluate the available data.

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[1] Henry Ford II in "The Clean-cut Issue of Clean Air", The Washington Post, November 23, 1970, p. A-16. Setting standards at any level above zero is not consistent with the traditional way our laws treat such noxious situations. This is cleverly brought out by Professor Ernest Starkman, an expert in automotive technology, "It's like 'litter-bugging'. We don't establish limits permitting one to throw three gum wrappers and one pop bottle out the car window per mile. Instead, the edict is, 'Thou shalt not litter.'" Address to California University Engineering Alumni Society, October 23, 1969, cited in Ideas (Washington, D.C.: International Research and Technology, January 1970), p. 5.

The mounting public demand for clean air has essentially elevated the issue to "motherhood status".[1]

Uniformity. Uniform, "across-the board" standards are the simplest to administer, but may be substantially more costly to society as a whole, as well as inequitable to large numbers of rural motorists. All motorists, whether they drive one thousand or ten thousand miles a year, or whether they drive primarily in rural areas or urban areas, must purchase a car with expensive pollution control equipment. The cost to society will also include a decrease in the kinds of vehicles that can be offered for sale. There is evidence that many large, high performance vehicles and many foreign makes will not be able to meet forthcoming standards. With respect to foreign cars, standards may essentially constitute a trade barrier over and above tariffs and quotas.[2]

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1. As one congressional aide remarked recently, "Clean air is a good, conservative, middle class issue and no one can afford to be on the wrong side these days." Cited in "With Even the Silent Majority Opposing Air Pollution, the Nixon Administration is Apt to Take a Hard Line Against Detroit" by William Chapman, The Washington Post April 5, 1970, p. E-1. A few weeks later, the Senate passed its version of the stringent 1970 Amendments to the Clean Air Act (S-4358) by a vote of 73-0. This, however, cannot be taken as a sign of the times. Unanimous votes on Clean Air Amendments have become a Senate tradition. Though, one might have expected some dissent this year as the bill contained highly controversial provisions.

2. The unintentional discrimination against foreign cars may seriously affect the economy of some European countries. For a discussion of the difficulties faced by foreign car manufacturers in meeting United States' standards and the possible effects, see "U.S. Auto Pollution Standards and Foreign Cars", by Claire Sterling, The Washington Post, November 9, 1970.

## Enforcement of Standards

It is not enough just to set limits on maximum allowable emissions; provision must be made to ensure the promises of law are translated into reality.

Organization. In establishing an enforcement program, a basic policy consideration is how the responsibility is to be divided between the Federal Government and the states. The logical division of responsibility coincides with the characteristics of automobile manufacture and use. Since automobiles are marketed on a national basis, the Federal Government is best suited to determine whether new automobiles are conforming to standards. The completely decentralized use of automobiles, however, makes it far more efficient for states or regions to monitor the continued effectiveness of the control system in individual automobiles. This general division of responsibility has been adopted, though as will be seen below, state emission checking programs are only in the planning stage.[1]

Testing procedure. Obtaining a reliable measure of the roughly eight million passenger vehicles manufactured each year is a complex undertaking. It requires a comprehensive test cycle (idle, acceleration, deceleration, etc.) if results are to be representative of emissions during actual automobile usage. Suitable procedures for

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1. Since federal enforcement is directed at manufacturer's compliance and state enforcement is directed at individual motorists, the development of state inspection programs will be discussed in the following chapter.

determining durability must be developed in spite of the short time allowed for testing. Also, criteria must be developed for determining how many vehicles to test and how ratings are to be evaluated.

The federal program to test and certify whether new cars are actually in conformance with the existing standards has been heavily criticized. Currently, tests are made on a sampling of prototype engines -- only 1,200 cars were tested last year. Although the prototypes received special handling and are not the ordinary assembly line product, a certificate of conformity issued to a particular prototype extends to every vehicle ". . . which is in all material respects substantially the same construction as the /certified/ test vehicle."[1] Government ground rules permit special fine tuning before the prototypes' emissions are measured (supposedly to correspond with dealer tunings prior to sale), the "averaging" of high and low emitters (only the "average" must be in compliance with federal standards), and durability tests with quick mileage accumulation (i.e., avoiding so far as possible starting, stopping, foul weather, corrosion and similar factors likely to degrade the pollution control system.)

Serious doubts were cast on the validity of this testing procedure by the results of a surveillance program instituted with the aid of a rental car corporation. The data, compiled by examining 1968 models driven by the public, revealed a startlingly high rate of control system deterioration. Slightly more than one-half of the cars tested failed to meet either the hydrocarbon or the carbon monoxide standard.

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1. Air Quality Act of 1967, P.L. 90-148, Sec. 206(b).

For more than one model, more than 80 percent of the cars tested failed one or more tests.[1] Reports in 1970 show hydrocarbon emissions higher than the standard by 25 percent and carbon monoxide by about 10 percent -- up from the 20 percent and 8 percent figures measured the year before.[2]

The failure of production line vehicles to perform as well as their prototypes has serious implications for air quality. Appendix B shows the estimated effect on projected air pollution levels of this failure of production line vehicles to remain in compliance with automotive emission standards. The charts show quite clearly that continued failure of production line vehicles to meet federal standards will jeopardize long term air quality gains. In addition, such failure means that short of extensive maintenance programs, the consumer expenditures (estimated at $15 billion since 1968) were substantially worthless.

New, more realistic test procedures, as well as more accurate evaluative methods and measuring equipment were announced by NAPCA on July 15, 1970. These changes in the certification testing procedure are expected to close the "loopholes" that existed under the old procedure. The Clean Air Act Amendments of 1970 also make explicit provisions for assembly-line testing of vehicles and give clear authority to the Administrator of EPA to revoke certificates of conformance for any vehicles not yet delivered by the manufacturer. Also included in the legislation is a warranty provision which will require development of a more durable emission control system (see p. 1-32). The new legislation also makes federal certification a legal requirement for the sale of new vehicles. Heretofore certification was voluntary, although all auto manufacturers applied for the certificates for all of their model lines.

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[1] Source: Interim Report -- Rental Car Surveillance Program, March 1968 to November 1969, Division of Motor Vehicle Pollution Control, Bureau of Abatement and Control, National Air Pollution Control Administration.

[2] Environmental Quality. The First Report of the Council on Environmental Quality. Transmitted to Congress, August 1970, p. 77.

## Economic Incentives: Emission Charges

As a supplement to the prevailing federal approach of new car emission standards, federal policy makers could levy a charge on auto manufacturers directly proportional to the emissions from new motor vehicles. Automakers would then have an incentive to reduce pollution, as to do so would minimize their costs. There has been only slight attention given to such a policy; two bills were introduced in the House of Representatives in the Ninety-first Congress seeking to make federal excise taxes a function of engine horsepower and pollution emissions.[1] However, the announced intention of this legislation was to raise money for prototype development and federal purchase of pollution-free automobiles, not to induce automakers to make lower pollution automobiles.

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1. H.R. 17202 (Farbstein); H.R. 18980 (Ottinger).

A recent study to be published shortly by the National Academy of Engineering outlines in detail the characteristics of an emissions charge scheme aimed at auto manufacturers.[1] Under the charge plan assumed in that analysis, a fixed charge would be applied for each ton of the three gaseous pollutants emitted by automobiles at the time of manufacture and for as long as cars of that model year were on the road. The annual charge to the auto manufacturers would be a function of the number of cars of a given model year and their emission levels at that time. This could be determined inexpensively and reliably by a random sampling of a small fraction of the actual number of vehicles of any model. A charge system of this nature, it is argued, would give manufacturers the incentive to develop pollution control technology and to produce control devices whose performance does not degrade over time.

Advantages.[2] Charges can be adjusted so as to produce any desired level of emissions.[3] Thus the same reduction in emission levels can be reached as under the standards approach, but at a lower social cost. The latter will be true since there will be no required curtailment in production of any vehicle (see "Uniformity" above), but, ideally, there will be a readjustment in the pollution levels of vehicles and the quantities of different models produced as automobile manufacturers seek to produce that "mix" of automobiles which will lower costs as well as satisfy customer demands.

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[1] Adrian J. B. Wood, J. Serge Taylor, Frederick R. Anderson, Laurence I. Moss, Strategies for Pollution Abatement, Committee on Public Engineering Policy, National Academy of Engineering (Washington, D.C.: January 22, 1971), pp. 6-55 to 6-80.

[2] For a more extended discussion of the advantages of emission charges, see Chapter 5, "Emission Charge Systems".

[3] For example, applying a charge of $200 per ton for hydrocarbons, $200 per ton for nitrogen oxides, and $10 per ton for carbon monoxide, it is contended, will be the equivalent of the new emission standards required to be met in 1975-76.

A charge system of this type would reduce the characteristic government-industry debate over technological feasibility and economic cost which generally precedes the establishment of new sets of standards. Once the charge is established (and admittedly there will be a great debate at that time), technology and cost considerations will be factors debated within the firm and not between the auto companies and any government agency as is currently the case.

Problems. Auto firms need not necessarily consider the recurring maintenance and operating costs associated with various control devices. Thus, they could lower their costs under the charge scheme at a substantial cost to consumers.

At a more basic level, the auto industry might be sufficiently oligopolistic to ignore the charges incentives if it should choose to do so. Even if one takes for granted that the auto firms will pass the charge onto consumers, the possibility exists that they will make little effort to reduce emissions.[1] However, in such a case the careful scrutiny applied to the behavior of the auto industry would almost certainly call forth governmental action -- either in the form of anti-trust suits, higher charge levels, or new legislation. Furthermore, such behavior would be unlikely if the charge system necessitated a large price increase for new cars.

While there would probably be few objections -- beyond the resistance of vested interests -- to "small" or "moderate" charges, "steep" emission charges (or the outright ban of higher emitting engines under a stringent standards approach) raise significant political questions.

In the Senate Hearings on air pollution, a public witness strongly advocated that large horsepower engines should be "outlawed outright, or taxed very heavily." She saw "absolutely no reason for anything over 200 hp" and suggested federal efforts "to obtain equal time to answer the 400 horsepower car ads."[2]

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1. The possibility under an emission charge approach that auto manufacturers would make little effort to reduce emissions essentially means that such approaches must be coupled with direct regulation (e.g., new car emission standards) if they are to be successful.

One possible factor motivating the auto industry to sabotage an emissions scheme would be that: "By not responding any differently to the emission charges than they claim they would have responded to 'reasonable' standards, the auto firms might hope to discredit the use of emission charges and return to 'voluntary compliance' and 'reasonable' deadlines." Adrian J. B. Wood, J. Serge Taylor, Frederick R. Anderson, Laurence I. Moss, Strategies for Pollution Abatement, Committee on Public Engineering Policy, National Academy of Engineering (Washington, D.C.: January 22, 1971), pp.6-55 to 6-80.

2. Dr. Ruth Weiner, President, Colorado Citizens for Clean Air. Hearings before the Subcommittee on Air and Water Pollution of the Committee on Public Works, United States Senate, 91st Congress, Second Session, March 16, 1970, pp. 76-78.

In reply, Senator Muskie placed this policy suggestion in a larger context, and in doing so, gave considerable insight into the problems of translating such good intentions into public policy:

> You are talking about the size of an automobile engine. It goes much beyond that. . . . How far do we go in actually limiting the kinds of products that can be produced, the kinds of consumer tastes to which private enterprise will be free to serve? Just what limitations do we impose in a consumer-oriented society, that is also free in the kinds of products that we manufacture, the kinds of products that people can buy?
>
> It is relatively easy to say -- the size of an automobile engine is an obvious one. But then you go beyond that, and we are going to have disagreement as to how big an automobile engine. Then there are going to be those who say maybe we ought to go to something else . . .[1]

## Economic Incentives: Research and Development Grants

The reduction of auto air pollution emissions requires that research into pollution control techniques be accelerated. The auto industry, as discussed above, has indicated its determination to clean-up the internal combustion engine and has indicated repeatedly that such research efforts are not hampered by lack of funds.[2] Federal support, however, could encourage research by non-industry firms who operate with substantially smaller research and development budgets.

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[1] Hearings before the Subcommittee on Air and Water Pollution of the Committee on Public Works, United States Senate, 91st Congress, Second Session, March 16, 1970, p. 77.

[2] The vice-president in charge of General Motors' Research Laboratories recently testified, "At no time since I have been associated with the research laboratories have we really been limited by money or facilities. We are primarily limited by ideas. . . ." Paul F. Chenea, Hearings before House Subcommittee on Public Health and Welfare, 91st Congress, First Session, Serial No. 91-49, December 9, 1970, p. 114.

the Federal Government has developed a plan designed to stimulate such research and development by private contractors. The National Air Pollution Control Administration Motor Vehicle Research and Development Plan is a six-year plan (Fiscal 1970-75) for federal research development relating to the prevention and control of motor vehicle pollution.[1] In part it will provide funds over the next six years for the research and development of new, improved techniques for controlling emissions from gasoline-fueled engines. As currently anticipated, this money will be used largely for contracts with private firms but also will permit some in-house research. It is not expected that the plan will provide any significant increases over the current level of funding for conventional engine research and development over the next six years. This reflects the federal position that private industry will be committed to improving the internal combustion engine and that federal spending for research and development should be focused on unconventional engines.

## Legal Approaches

Since both the automobile and oil industries are characterized by a close-knit group of large sellers, the application or modification of antitrust laws is possibly the major recourse in law to control auto

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1. A brief summary of this plan can be found in Hearings before the Subcommittee on Air and Water Pollution, United States Senate, 91st Congress, Part 1, March 1970, p. 361.

emissions. Application of antitrust laws requires careful consideration of two opposing factors. On the one hand antitrust laws can be used to prevent conspiracy and promote competition in the development of pollution control technology; on the other, stringent enforcement (or realistic threats of such enforcement) could essentially prevent meaningful, cooperative research, especially inter-industry research. In this regard, antitrust laws might require modification to permit specific activities which might otherwise be unlawful. These possibilities concerning the use of antitrust laws will be discussed in detail below. This section will also discuss two other legal approaches: (1) warranties as a means of stimulating the auto industry to develop durable pollution systems, and (2), legal remedies available to entities who have reason to believe the EPA Administrator is derelict in performing his statutory obligations to reduce auto air pollution.

Conspiracy. The inactivity of the automakers in developing pollution control equipment, especially in the Fifties and early Sixties, has resulted in a large number of court suits charging the major auto manufacturers (and often several co-conspirators) with conspiracy to delay development of automobile smog devices and conspiracy to control the pace of installation of such devices. If such an assertion could be proved, it is conceivable the automakers could be required to establish a crash program for installation of pollution control devices at no (or reduced) cost for all motor vehicles produced during the years in question (generally 1953-1970). Complainants could also be awarded millions of dollars in treble damages.

Federal antitrust litigation. The Federal Government was the first to allege such behavior in a suit filed in January 1969.[1] This action was resolved in September 1969 by a consent decree, in which the automakers did not admit guilt, but agreed to cease and desist from the alleged activities as well as accept certain behavioral guidelines designed to insure compliance with the consent decree.[2] The consent decree offer of the Justice Department (a relatively favorable resolution for the automakers) and the court's acceptance were unpopular with environmentalists in and out of government.[3]

The following month, a U.S. District Court Judge rejected the numerous petitions to intervene brought by a number of city and state governments as well as private individuals. The court held that they lacked standing to intervene but in an unusual action the judge ordered that the exhibits and Grand Jury testimony be impounded and made available to future litigants.[4]

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1. U.S. v. Automobile Manufacturers Association, Inc., 1969 Trade Cases, paragraph 72,907, D.C.D., Calif.

2. Civil Action No. 69-75-JWC. D.C.D. Calif.

3. One expert points to this case as an illustration of both the attitude and the power of the automobile companies. The consent decree does not impose any penalty on the manufacturers and normally seals the Grand Jury records, thus closing off information that might be used in other damage suits. In addition, he claims, the fact that the suit was initiated only ten days before the Johnson Administration left office "probably indicates the reluctance of the Administration to incur the wrath of the auto companies." J. Clarence Davies, III, The Politics of Pollution (New York: Pegasus; 1970), p. 94, p. 214 fn.

4. For a discussion of standing in air pollution litigation, see Governmental Approaches to Air Pollution Control: A Compendium and Annotated Bibliography, prepared for the National Air Pollution Control Administration by the Institute of Public Administration, Contract No. EHS 70-126 (Washington, D.C.: 1970), Chapter 5, "Private Legal Action"

State and private antitrust litigation. The parties denied standing to intervene in the federal suit then brought individual (class action) suits. These suits are based on the assertion that anti-pollution devices would have been standard equipment on vehicles now, but for the manufacturers' alleged agreement not to compete in developing them. They claim damages to public buildings, greenery, increased benefits to welfare clients suffering from pollution-related diseases, and increased expenses to combat air pollution.

On September 4, 1970, a federal Court granted these litigants the right to pursue their suits (which were consolidated for pre-trial motions). This is the first ruling to grant parties who were not involved in a commercial relationship with the alleged conspirators the right to recover under federal antitrust laws for damages suffered as a result of such conspiracy. This decision cleared the way for about twelve separate suits filed in courts throughout the nation. The complainants will have to prove that a conspiracy existed and that their damages resulted from it.[1]

The chances are slim that the complainants will receive the kind of relief that can have a significant impact on air quality. The cost to industry of a retrofit program would be enormous and it is not likely that the courts will grant such relief. It is more probable that the significance of the large number of suits will be the message they carry to the auto industry -- that the public and government are aroused and are subjecting industry's behavior to careful scrutiny.

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[1] Forty-seven of the fifty states are still capable of entering such suits. Michigan, Delaware and Wisconsin cannot do so because they house the major automotive corporations and a state cannot sue its own citizens.

Restructuring the auto industry. Thus, the threat of future litigation will also be an important consideration in the auto industry's decisions about pollution control. Of particular concern to the auto industry is the threat of antitrust enforcement to restructure the industry. Ralph Nader, among others, believes vigorous technological competition can only be guaranteed if the Federal Government enforces existing antitrust laws and restructures the automobile industry.[1] A recent work by a colleague of Nader's also takes this position:

> The only way to deal with the problem of corporate gargantuism, especially in the auto industry, is to dissolve the major companies and to establish an optimal number of smaller corporations. . . . a reduction in the size of huge automobile corporations is the first step towards creating a balance of power between the people and the polluters. True competition . . . would shift some profit-making energies in the direction of quality products (including, of course, products which do not pollute).[2]

But even this harsh critic of the auto industry realizes the overwhelming obstacles to implementing such a policy:

> Admittedly, the rearrangement of the largest manufacturing industry in the world is a formidable, perhaps unrealistic undertaking. But we are discussing solutions, not political expedients.[3]

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1. Testimony before an ad hoc committee of New York Representatives cited in Ideas (Washington, D.C.: International Research and Technology, December 1969), p. 115.

2. John C. Esposito, Vanishing Air (Grossman; New York, 1970), p. 360.

3. Ibid.

Research activities. Concern exists over whether the antitrust laws will permit information-sharing and joint research projects of the sort that could substantially contribute to rapid development of new emission control technology. Critics of the automobile industry claim that allowing close cooperation among members of that industry will invariably lead to a conspiracy to restrain new developments. And, in fact, the consent decree which resolved the federal conspiracy case prohibits a wide range of communications and cooperative endeavors among members of the auto industry.

The situation with respect to joint research efforts between the automobile and oil industries is less clear. A Commerce Department panel concluded a few years ago, "The Federal Government should recognize the need for meaningful joint research between industry groups and encourage these efforts by making reasonable allowances for appropriate activities in the application of Federal regulations."[1] In this regard, the Senate Subcommittee on Air and Water Pollution recently considered an amendment to the Clean Air Act which would authorize the automobile and petroleum industries to meet in a public forum under federal supervision. The Subcommittee's Chairman, Senator Edmund Muskie, solicited the views of Senator Philip Hart, Chairman of the Subcommittee on Antitrust and Monopoly. In reply, Hart felt such an exemption from antitrust laws was unnecessary for at least two reasons:

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1. The Automobile and Air Pollution, A Program for Progress, U.S. Department of Commerce (October 1967), p. 36.

> (1) Government instigated and supervised cooperation among competitors or between industries does not violate the antitrust laws; and,
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> (2) Even if this kind of conduct raised an antitrust issue, its legality would be measured by the rule of reason or clearance for cooperation may be obtained from the Justice Department.[1]

But even if further thought and examination indicated that an exemption was necessary to permit such behavior, Hart believes such a statutory enactment would not be desirable;

> . . .Unless an exemption is absolutely essential for the type of conduct the bill seeks to encourage, I would be extremely reluctant to raise the issue in light of these complicating factors /pending antitrust litigation involving automobile industry/. In addition, most exemptions cover far more ground than is necessary and often result in conduct which might ultimately frustrate the very purpose of the bill. It seems justified to suggest that the past record indicates a course of joint action to suppress innovation in pollution control technology and that antitrust policy has been used to end this type of conduct. At this juncture it does not seem wise to remove antitrust controls to promote innovation, since the ultimate result may be a repetition of what has apparently occurred in the past.
>
> The spur of competition may well prove to be the most reliable mechanism for insuring the development of technology to meet the proposed bill's 1975 standard. It is my hunch that forced cooperation may result in both the petroleum and auto manufacturing industries relaxing their research efforts. One may reasonably ask: "Why expend great sums in research when we can get access to everyone else's research?" Absent the incentives of competition, I am not very confident that the management of any

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1. Letter from Senator Philip A. Hart to Senator Edmund S. Muskie. Reprinted in Hearings before the Subcommittee on Air and Water Pollution, United States Senate, 91st Congress (1970), Part 5, p. 1669.

> of the firms involved in these industries could justify the necessary large research expenditures. If it is feared that one firm may corner the technology through patents, trade secrets, or know-how, your Committee may wish to consider the desirability of mandatory licensing at reasonable royalties of proprietary information which would assist in ultimately achieving the proposed Act's 1975 emission standard.[1]

The Subcommittee accepted Senator Hart's suggestion and included provision for mandatory licensing in the new legislation. This provision establishes a procedure by which patents can be made available to persons who could not otherwise meet the emission standards required by the Act. If such need is established and it can also be demonstrated to the satisfaction of a district court that the unavailability of a patent may result in the lessening of competition, the court may require the owner of the patent to license it on such reasonable terms and conditions as the court determines.[2]

Warranty. As a supplementary measure to the federal certification program, reliability and durability could be encouraged by the use of warranties. If pollution control devices are to have a significant impact upon air quality, they must retain their effectiveness for many thousands of miles.[1] One type of warranty would require that automobile manufacturers (through their dealers) guarantee the continued effectiveness of pollution control systems. If a motorist could show his automobile was emitting pollution in excess of the standards, he would have legal standing to require the automobile dealer to repair or replace the control device at no cost.

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[1] Letter from Senator Philip A. Hart to Senator Edmund S. Muskie. Reprinted in Hearings before the Subcommittee on Air and Water Pollution, United States Senate, 91st Congress (1970), Part 5, p. 1669.

[2] P. L. 91-604, Section 308. This is a much "watered-down" version of the final Senate draft of the legislation. In addition to patents, the Senate bill would have included provision for mandatory licensing of trade secrets and know-how. See National Air Quality Standards Act of 1970. Report of the Committee on Public Works, United States Senate, September 17, 1970 (S. 4358 Sec. 309).

Performance warranties, however, suffer from one general deficiency which is a particular problem with pollution control systems. Control systems require careful maintenance and periodic adjustment,if they are to retain their effectiveness.[2] Consequently, it is extremely difficult to distinguish between the manufacturer's liability and the consumer's misuse of the product. The inability to determine whether a vehicle has been "properly maintained, serviced, and operated" may result in performance warranties being unenforceable.

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1. Lifetime performance, however, is not an absolute necessity at the current time. If present control systems could remain effective for 5 - 6 years, they would make a great impact on air quality during the critical period prior to the introduction of low emission vehicles at mid-decade.

2. The degree of maintenance and attention required of motorists by auto manufacturers brings up a basic question -- where is the threshold beyond which a control system should be declared to require "unreasonable" amounts of maintenance and attention and should not be certified. One estimate of the recurring costs for maintaining existing control devices and those proposed is $6 billion annually. Should motorists be required to bear this burden or should the auto manufacturers be required to build more foolproof systems as a requirement for Federal certification? (Source of estimate: William H. Lear, Joint Hearings on the Federal Low-Emission Vehicle Procurement Act, Serial No. 91-51, January 29, 1970, p. 132.)

The auto industry also believes it is not reasonable and may well be unconstitutional to require a manufacturer to warrant and replace a system since he has no reliable basis for predicting the performance of the new technology, and, thus, cannot include the warranty cost in his prices. In addition, the industry contends that the difference between the emission standards and the actual performance of those vehicles with emissions in excess of the standard would probably not be great enough to have any real effect on ambient air quality.

For these reasons, the auto industry favors a much weaker "defect"warranty. This is the standard type of warranty wherein the manufacturer will replace or repair the system only if performance is impaired as a result of a defective part or assembly. The Clean Air Act Amendments of 1970 include a defect warranty but also provide that once local auto inspection stations are capable of checking emissions, a five-year or 50,000-mile performance warranty will go into effect.[1]

Citizen suits. The Clean Air Act Amendments of 1970 also authorize citizens to bring suits to enforce any standard issued under the Act or to compel the Administrator to perform any nondiscretionary duty created by the Act. This provision was included despite the strong objections of the automobile industry. The industry contends that firm standards are needed two years in advance

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1. P.L. 91-604, Sec. 207.

of implementation, and if such standards can be placed in doubt by a citizen suit against the Administrator, manufacturers will be left in doubt as to what their course of action should be.

The Automobile Manufacturers Association cites further problems with citizen suits.

> . . . serious problems are raised by the possibility of citizens suits to punish or enjoin alleged violations of existing standards. In the administration of new, highly technical regulatory statutes, manufacturers must necessarily work out with the agency technical interpretations of what the applicable test and inspection procedures are to be. If manufacturers cannot rely on interpretations made and practices followed by the agency -- if such reliance can be upset after the fact by a citizens enforcement suit, effective day to day compliance with the agency's regulations will be made infinitely more difficult.
>
> No reason has been suggested why, in the absence of citizens suits, the Secretary /Administrator/ would fail to perform his duties under the Act, or why in the event of a violation the Secretary and attorney general would fail to take the necessary enforcement measure. Citizen complaints to the regulatory authorities may be helpful; a multitude of citizens attorneys general bringing enforcement suits in the courts are more likely to be harmful. No other federal regulatory statute is enforced in such a helter skelter manner. The effective regulation of air pollution is too critical for such an experiment.[1]

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[1] Letter to HEW Secretary Richardson from Thomas C. Mann, President of the Automobile Manufacturers Association, August 27, 1970. Reprinted in Hearings before the Subcommittee on Air and Water Pollution, United States Senate, 91st Congress, Second Session, Part 5, March 1970, p. 1576.

## Encouraging Development of Unconventional, Low-Emission Vehicles.[1]

The uncertainty surrounding the speed with which the internal combustion engine can be cleaned up, the costs of doing so, and the ultimate limits that can be reached, require programs be undertaken to develop an alternative power plant. The major auto manufacturers, however, are committeed to improving the internal combustion engine. This commitment is based upon a combination of several factors (not necessarily in order of importance):

1. The belief that the internal combustion engine can be cleaned up sooner and at lower cost than any other engine.
2. The large investment in physical plant, parts, and technical know-how associated with the internal combustion engine.
3. Consumer acceptance and familiarity with the conventional engine.
4. The threat to the strong alliance between the automobile manufacturers and the oil industry.

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1. Among the most promising alternatives to the internal combustion engine are the steam engine, gas turbine engine, and a hybrid engine (a low-powered fuel burning engine with an array of electrical batteries). For a comprehensive survey of unconventional power plants, see Report of the Ad Hoc Panel on Unconventional Propulsion, Panel of the Office of Science and Technology (Washington, D.C.: February 16, 1970).

Although each of the "Big Four" automakers has ongoing programs to develop unconventional low emission vehicles,[1] the industry's priorities are so heavily oriented to the internal combustion engine that most non-industry experts agree with the President's Air Quality Advisory Board which concluded,

> . . . /the/ automobile industry lacks sufficient motivation to design unconventional powerplants and therefore it seems clear that some governmental encouragement of non-auto companies and additional stimulation of vehicle manufacturers is necessary.[2]

Such governmental encouragement and stimulation can take several forms.

Direct Regulation

Standards. The emission standards approach described above, will not provide the required motivation for accelerated development of an unconventional power plant. The automakers are determined to meet the stringent standards by intensifying their efforts on the internal combustion engine. However, insofar as standards are

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1. The existence of such programs does not, in itself, imply a commitment to finding an alternative to the internal combustion engine. One critic claims precisely the opposite is true, "automobile industry research into alternative sources of propulsion has been directed not at finding solutions, but at discouraging further interest in alternatives." Examples given include one auto company's manufacture of a steam propelled automobile using factory boiler specifications which resulted in the vehicle being overly large and cumbersome. See John C. Esposito, Vanishing Air (New York: Grossman, 1970), Chapter 2.

2. The Washington Post, December 18, 1970. Cited in Ideas (International Research and Technology, January 1970), p. 3.

an indication of the desire of the Government to control the source, the current standards serve notice on manufacturers that the Government will require a (nearly) pollution-free vehicle. This may serve to stimulate entrepreneurial activity on the part of those manufacturers who feel the internal combustion engine will not be able to meet the standards or will not be competitive with a well designed, low emission vehicle.[1]

Ban of internal combustion engine. Each session several bills are introduced into both houses of Congress seeking to ban the sale of automobiles with internal combustion engines by a specific date if such engines cannot meet certain low emission criteria.[2] The intent of such legislation is to give automakers an ultimatum somewhat stronger than under the standards approach. However, there has never been any action taken with regard to such bills at the federal level. Most policy makers are reluctant to ban the internal combustion engine before it is clear an unconventional vehicle could be marketed in its place. Also, the uncertainty surrounding the pollution control potential of the internal combustion engine makes it unfairly discriminatory to outlaw that engine when many interests (including some with substantial investments at stake) contend it offers the best potential to meet clean air needs.

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[1] A letter by American Motors Corporation (the Big Four auto company having the least stake in the existing market) to the Senate Commerce Committee indicates that this might be the case. " As you might imagine, American Motors is highly interested in developing a low emission, mass-produced automobile. Not only would this have advantages from a social point of view, but we look upon it as a rare opportunity for our company." (January 24, 1969.) Cited in The Search for a Low-Emission Vehicle, Senate Commerce Committee Staff Report, 1969, p. 29.

This report argues that American Motors was the only one of the "Big Four" auto manufacturers to express a serious commitment to work on an unconventional engine such as the Rankine cycle (steam), as opposed to the gas turbine which is relatively similar to the present internal combustion engine.

[2] For example, see S. 3276 (90th Congress, 1969) -- a bill sponsored by Senator Gaylord Nelson to ban the internal combustion engine if it could not meet low emission standards by 1978. At least nine states introduced such bills into their legislatures in 1969-70. but only in California did the bill have any success -- it passed the California Senate but died in the Assembly Transportation Committee.

## Economic Incentives

The research, development, and production costs of unconventional vehicles will be enormous. The auto industry takes the position -- as it does with respect to conventional engine research -- that no outside support could serve any useful purpose in hastening development of an alternative to the internal combustion engine.[1]

Independent developers are in a completely different situation. Beside working with a substantially smaller research and development budget, these firms face the huge costs of acquiring facilities and tooling up for production. The cost of this activity, including the funds needed for working capital to begin production, is estimated

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1. In a letter to a Senate Subcommittee investigating various financial incentives for development of a low emission vehicle, J. M. Roche, President of General Motors, typified the industry position, ". . . We at General Motors need no incentive, such as your bill /federal procurement of low emission vehicles/ would provide. However, your bill could induce others to seek a solution to the problem . . . ." Joint Hearings on the Federal Low Emission Vehicle Procurement Act, Serial No. 91-51, January 29, 1970, p. 90.

to be $275 million.[1] Independent manufacturers will also face a huge marketing cost; the price of direct entry into the passenger vehicle market has been estimated to be $300-$400 million.[2] This includes the money necessary to set up nationwide dealerships as well as the money required to sustain a fairly high rate of production in order to produce the vehicle at a cost competitive with the internal combustion engine. The possibility exists that independents could reduce such costs by either selling engines to existing auto manufacturers or by buying incomplete vehicles (lacking engines and transmissions) from them. However, there are serious questions as to whether the automobile industry would agree to such arrangements on principle, or even if such arrangements are economically and legally practicable.[3]

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1. William H. Lear, President of Lear Motor Company, Testimony at Joint Hearings on the Federal Low-Emission Vehicle Procurement Act, Serial Nol 91-51, January 29, 1970, p. 132.

2. "The Search for a Low Emission Vehicle", Staff Report prepared for the Committee on Commerce, United States Senate, 1969, p. 23.

3. Even if auto manufacturers were to agree in principle to purchase unconventional powerplants from non-industry sources, there would be a very serious split liability and warranty problem. The possibility of purchasing incomplete vehicles at wholesale prices raises the same legal problems. Furthermore, such purchases would create unbalanced production, procurement, and inventory problems on the part of the conventional auto manufacturers. For a more complete discussion of the problems facing independent manufacturers, see testimony of William H. Lear, President of Lear Motor Corporation, Joint Hearings on the Federal Low-Emission Vehicle Procurement Act, Serial No. 91-51, January 29, 1970, p. 130-32. Mr. Lear is currently involved in Rankine cycle (steam car) development.

Research and development funds. In view of the previous discussion, one economic approach to stimulate development of inherently low polluting vehicles is to provide independent contractors with research and development funds for the purpose of allowing them to meet the costs of prototype development. The National Air Pollution Control Administration's six-year research and development plan will provide substantial funds for unconventional vehicle research and development.

Prototype procurement. As a further incentive to stimulate development of an unconventional vehicle, government at all levels could purchase prototype vehicles. Such a policy would underwrite some of the costs of unconventional vehicle development as well as encourage mass production. It also would provide controlled conditions for field testing of new concepts in automotive propulsion.

The recently announced Federal Clean Car Incentive Program will provide for purchase of prototypes that meet performance, safety, durability, and other requirements as well as low emissions criteria. The program is designed in three phases intended to provide graduated financial incentives to private developers. The Federal Government will examine data and possibly test a few vehicles in the prototype phase, purchase ten vehicles in the demonstration phase, and some 100 vehicles for extensive tests in the fleet testing phase.

Distribution. Direct federal support for the marketing of specific consumer products by a segment of private industry raises questions of political acceptability. An indirect subsidy in the form of a legislatively guaranteed market provides a sound alternative; it can substantially lower marketing and production costs of private developers as well as reduce pollution from federal property.[1] A guaranteed market will allow a reasonable rate of initial production (the Federal Government purchases 60,000 cars per year), and thus initial costs of low-emission vehicles can be made competitive with existing vehicles. Also, large capital outlays for nationwide dealerships and servicing centers would be unnecessary as sales and servicing can be provided centrally for federal agencies. Procurement legislation, in addition, could create a consumer demand for low emission vehicles which in turn might stimulate the conventional auto manufacturers to redirect their efforts.[2]

The cost to government of a guaranteed market plan depends upon the premium paid for low emission vehicles. In California, the

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1. Executive Order No. 11507 (February 4, 1970) to reduce the pollution from federal facilities was recently amended to include vehicles.

2. A statement made by the Ford Motor Company substantiates this possibility, ". . . it is often assumed that our industry would resist any radical change in automotive power systems because of our tremendous investment in existing production facilities. On the contrary, one of the reasons we are continually examining new power sources is that we must periodically update our designs, plants, and equipment to meet the ever changing demands of our customers." (emphasis supplied) Cited in The Search for a Low Emission Vehicle, Staff Report for the Senate Commerce Committee, 1969.

low emission procurement plan allows the price of an unconventional vehicle to be double that of a comparable conventional vehicle. A recent Senate bill favored a 25 percent differential for improved conventional vehicles and 50 percent for those with inherently low polluting engines. The 1970 Amendments to the Clean Air Act provide for a 50 percent premium for the improved conventional vehicle and, like California, permit a 100 premium to be paid for an inherently low polluting vehicle. Five million dollars is authorized for Fiscal 1971 and $25 million for each of the two succeeding years.[1]

## Encouraging Development of Low Pollution Fuels

Since air pollution is the byproduct of the combustion of fuels, the development of low pollution fuels should be an important component of the federal strategy to curb auto air pollution. The necessity of continuous fuel purchase, as opposed to the option of purchasing an emission control device, reinforces the benefits that would accrue from the availability of cleaner burning fuels for all cars.

### Oil Industry Research

Current petroleum industry research programs to develop low polluting automotive fuels are directed to three basic areas:

1) Reducing the volatility of gasoline. This aspect of the auto air pollution problem will be less and less important as automobiles

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1. The Clean Air Act Amendments of 1970, P.L. 91-604, Section 212 (e)(i).

with the 1971 evaporative controls are phased into the vehicle population. Although such fuel reformulation would be redundant for automobiles, hydrocarbon evaporations would be reduced from refineries, tank farms tanker trucks and service stations.

2) Reducing smog-producing character of gasoline hydrocarbons. The smog potential of auto emissions could be reduced by replacing the olefins (photochemically reactive hydrocarbons) in gasoline with less reactive substitutes. As above, the fuel marketing chain would also benefit from this modification.

3) Reducing the amount of lead compounds in gasoline. Lead compounds are added to gasoline as the cheapest way of raising the octane rating of gasoline. A high-octane rated ("premium") fuel is needed by high compression engines to eliminate engine knock. The case for the reduction or elimination of lead in automotive fuels is based on several factors:

a) Health. Although not conclusively established as a hazard to health, consideration of the available evidence along with the associated risks dictate programs be undertaken to reduce or eliminate lead from gasolines.

b) Deactivization of catalysts which may be necessary to reduce the emission of other pollutants. The automobile industry claims it may not be able to meet future emission standards without use of a catalytic type muffler which would reduce hydrocarbon and carbon monoxide emissions to harmless carbon dioxide and water. Lead emissions rapidly coat currently known catalysts and eventually render catalytic devices inoperative.

c) Increased emission levels of other exhaust pollutants. Leaded fuels result in a higher rate of hydrocarbon emission than non-leaded fuels.

The petroleum industry is committed, in principle, to research and development of low polluting fuels. The industry has much to gain from the automobile industry's ability to meet emission standards with the internal combustion engine. Although almost all prospective vehicle power sources will require petroleum-based fuel of some sort, the cost of refinery conversion from high-octane petroleum to, say kerosene (steam engine requirement) would be huge. It would necessitate phaseout of existing refinery facilities and cause major disruptions in a large and established industry.

Despite the oil industry's desire to see the internal combustion engine meet future standards, the industry showed initial reluctance to remove lead from gasoline. Estimates of the total refinery conversion costs in order to produce lead-free gasoline range from $4.2 - $6 billion.[1] Marketing an additional fuel would also be costly.

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[1] Donald D. Kummerfeld, Gregory Wilcox, "Federal Policy on Auto Air Pollution Control", Research Report (Washington, D.C.: Center for Political Research, April 1970), p. 22.

Furthermore, the industry felt that, in view of the uncertainties surrounding new automotive technologies and the health effects of lead, the Administration and auto industry demands for lead removal were unwarranted. However, with the auto industry's announcement that the majority of 1971 model cars would be designed to use lower octane unleaded fuels, and under the threat of legislation which might ban the use of lead, all major gasoline producers have marketed, or will soon market, lead-free blends.

## Direct Regulation

Although "voluntary compliance" has been successful in the development and marketing of low-polluting fuels, federal policy makers have fought for and won the authority to regulate fuels. The need for such legislation has been denied strenuously by oil industry representatives.

### Oil Industry Position

The oil industry argues that auto air pollution control can be achieved more effectively by establishing proper emission standards rather than by imposing marketing and fuel restraints. The industry feels that on the basis of its past behavior, competition within the industry -- as well as between the oil, auto, and chemical industries -- could be relied upon to achieve reductions in auto pollution. Not only does the industry feel that control legislation is unnecessary, they argue that regulation of the means by which these industries strive to achieve emission reduction goals will be dangerous to the attainment of the goals themselves.[1]

## Federal Position

Federal officials concerned with auto pollution abatement believe that the authority to regulate the composition of fuels is an important safeguard to insure that all promising approaches are pursued. This authority could prevent the oil industry from delaying the removal of lead or substituting other, possibly dangerous, additives in its place. Also, such authority may allow the Federal Government to play an important third party catalyst role in combining the efforts of the auto and oil industries to reduce auto air pollution.

## Legislative History.

Fuel registration. The Air Quality Act of 1967 prohibited the introduction into interstate commerce of any fuels designated by the Secretary of Health, Education and Welfare unless additives contained in such fuels have been registered with HEW.[2] The purpose of this legislation was to permit thorough study of additives to determine possible adverse health effects when they or their combustion products are emitted into the air. On June 13, 1970, the Secretary of HEW designated motor gasoline as the first fuel requiring registration of additives. Information that must be submitted includes: the names of additives, concentration, purpose of each additive and summaries of information previously developed on the characteristics and effects of each additive (see Appendix C for recent related information). The Clean Air Act Amendments of 1970 also require the manufacturer, at the discretion of the Administrator of the Environmental Protection Agency, to conduct tests into the health effects of fuels or fuel additives.

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[1] See, for example, testimony of Robert C. Gunness, President, Standard Oil Company of Indiana, *Hearings* before the House Subcommittee on Health and Welfare, 91st Congress, Serial No. 91-49, March 5, 1970, pp. 243-262.

[2] P. L. 90-148, Section 210.

Fuel regulation. The Clean Air Act Amendments of 1970 provide the authority for federal control over fuel composition. However, the legislation stipulates that no fuel or fuel additive can be controlled or prohibited unless:

> . . . emission products of such fuel or fuel additive will endanger the public health or welfare . . . [or] will impair to a significant degree the performance of any emission control device or system which is in general use, or which the Administrator finds has been developed to a point where in a reasonable time it would be in general use were such regulation to be promulgated.[1]

The legislation also requires consideration of other technologically or economically feasible means of achieving emission standards before any action is taken to regulate fuel composition.[2]

## Economic Incentives

### Cost of Production

The Federal Government could subsidize some of the cost of new refining equipment needed to produce low polluting fuels by allowing for accelerated depreciation of such investments or by other partial cost subsidies. These are discussed in detail in the accompanying report on stationary source pollution.[1]

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[1] P.L. 91-604, Section 211(c).

[2] On January 30, 1970, the EPA Administrator published his intent to regulate the lead content of motor fuels. See Appendix C for details.

Cost of Purchase

In order to provide incentives for the purchase of clean burning fuels, a system might be devised that combined both taxes and tax reductions. In other words, the more a fuel pollutes the higher the tax imposed upon it; conversely, the lower the emission potential, the greater the tax reduction. The administrative difficulties of this type of approach, however, would probably prove too cumbersome for the scheme to warrant serious consideration.

The recent federal attempt to place a $4.25 tax on each pound of lead additive blended into gasoline is an example of a discriminatory tax designed to shift consumer demand to the low-polluting fuels. The lead tax would, in effect, remove the price differential between leaded and lead-free gas by adding about 2.3 cents to the price of leaded gasoline.[2]

Size of Market

The greater the market for low-lead fuels, the greater will be the motivation of the oil industry to produce low-lead fuels. As

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1. Governmental Approaches to Air Pollution Control: A Compendium and Annotated Bibliography, submitted to the National Air Pollution Control Administration by the Institute of Public Administration. Chapter 6, "Partial Cost Subsidies".

2. For a more comprehensive discussion of the lead tax, see Ibid., Chapter 7, "Economic Incentives", p. 7-21.

mentioned above, the recent decision of the automakers to reduce the compression ratio of most 1971 model cars so that they could run on lead-free fuel was an important factor in convincing the oil industry to market low-lead fuels. By imposing a discriminatory tax, the Federal Government could possibly reduce the supply of high compression cars (see pp. 1-20 through 1-24), or decrease the demand for such cars (see pp. 2-8 through 2-14 and Chapter 5). The Federal Government could also increase market size by requiring government vehicles to use lead-free gas. This policy has been adopted.

# CHAPTER 2

## CONSUMER CONTROL OF AVERAGE EMISSIONS PER MILE

In Chapter 1, discussion focused on policies aimed at industry to reduce average emissions per mile. In this chapter we shall consider the consumer, who also has an important role to play in this regard. The manner in which he exercises his options to buy automotive equipment and fuels, and the degree to which he keeps his car maintained, can significantly affect the quantity of emissions per mile driven.[1] As we have already noted, it is more efficient to monitor individual automobiles on a state or regional rather than on a national basis. Consequently, most of the policies discussed in this chapter have been envisaged for consideration at the state level.

The concept of an "emissions class" will be useful, both in this and subsequent chapters, as a means of summarizing the extent to which a motorist exercises his options to control pollution. The number of emissions classes represents the range of potential automobile emission levels -- from a nearly pollution-free vehicle to an almost completely inefficient and ill-maintained "smoke belcher". These classes could run from one (lowest pollution) to five (highest pollution), or even more. Thus, policy can be conceived as attempting to influence consumer behavior so that greater numbers of vehicles are in lower emissions classes. This can be accomplished by inducing motorists to do any of three things: purchase a new automobile; purchase a "used car" control device; pursue a regular maintenance schedule.

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[1] Emissions per mile can also be reduced by shutting off engines when waiting at the curbside for longer than three minutes, maintaining a constant speed and avoiding stops and starts so far as possible. However, the ability to drive in this manner depends largely on the design of the transportation network and this will be discussed in Chapter 4.

1. Purchase a new automobile. Motorists owning precontrolled (pre-1968) cars, or cars with less sophisticated control systems than available, could significantly reduce the pollution associated with their automobile use by purchase of a new automobile.[1] In addition, selective choice of a new vehicle using emissions as an important component of vehicle choice will make a substantial difference, as currently there is a wide range in emissions among new cars although all have similar control equipment. Automobiles with large displacement engines, eight cylinders and an automatic transmission, for example, now emit more pollution than a comparable vehicle equipped with a small displacement engine, six cylinders, and a standard transmission.[2]

2. Purchase a "used car" control device. Those motorists owning pre-controlled cars could purchase and have installed one of the several control devices currently on the market. As explained in Chapter 1 (p. 1-3), these devices are both relatively inexpensive (approximately $50 with installation) and reportedly highly effective

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[1] It should be borne in mind that this strategy probably will not produce an immediate marked improvement in air quality since many persons buy used cars, and, furthermore, only a certain potential volume of new cars is available annually. All this is to say that there will be only a gradual phasing out of the older, high-emitting car population -- probably at a rate of 10-12 percent per year.

[2] These differences in emissions associated with various car characteristics are only temporary. Effective with the 1970 models, an attempt was made to put all cars on an equitable basis, irrespective of car size, engine size, transmission type. Such equitability will become a reality in 1972 when a true mass emission measurement procedure is implemented.

(reducing hydrocarbon emissions by approximately one half and carbon monoxide and nitrogen oxides emissions by about one third).[1]

3. Maintenance. All cars, especially older ones, could benefit significantly from an annual tune-up. One study conducted recently showed that careful tuning of 43 cars resulted in a reduction of hydrocarbon and carbon monoxide emissions by over 50 percent at idle, an important consideration in city driving.[2] Periodic maintenance is also essential to keep pollution control systems operating efficiently.[3]

Policies to induce a shift in emissions classes can take two basic forms -- either policy makers can directly regulate the number of vehicles in different emissions classes, for example by requiring all automobiles to undergo an annual tune-up, or they can apply a discriminatory tax as an incentive for motorists to move to a lower emissions class. Some policies of each type will require the establishment of state programs to test emission levels while others will not. The question of whether to establish a state inspection program for auto emissions is a central decision facing policy makers and will be examined in detail below.

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[1] Preliminary evidence from APCO-conducted tests indicate that used car control devices are not truly as effective as indicated by their manufacturers. Thus, the material in this section regarding the retrofit strategy should be subject to review after true mass experimental data become available.

[2] Although a complete test cycle was not investigated, the researchers felt a less drastic, though significant improvement would have been observed. Cited in "The Implications of Lead Removal from Automotive Fuel," an Interim Report of the Commerce Technical Advisory Board Panel on Automotive Fuels and Air Pollution (June 1970), p. 15.

[3] Use of low polluting fuels was not included as a means of shifting from a higher to a lower emission class. It is almost impossible to devise an integrated policy which can induce motorists both to reduce the pollution potential of their vehicles and also to use clean burning fuels. As two distinct policy tacks will be necessary, the emissions class concept will be used for classifying policies which can accomplish the former while an incentive mechanism will be described below which can accomplish the latter.

## Direct Regulation

### Standards

As noted in Chapter 1, the Federal Government has preempted the right to set emission standards for new motor vehicles prior to initial sale. After transfer of ownership, however, states have the right to establish programs regarding emission levels of vehicles registered in the state. A typical program would involve establishing a set of standards and some sort of required (generally annual) emissions test. On the basis of the measured amount of pollutant emissions, the vehicle would either be in conformance with the standards or rejected and required to return after remedial action. The precise levels at which the standards are set will determine the steps most motorists will have to take to be in compliance. Stringent standards, for example, will require drivers of older, pre-controlled cars to get a tune-up and probably also purchase retrofit equipment. Since it will certainly be impossible to bring all older cars into compliance with the standards, some will be rejected and perhaps banned from the roads.[1] In this way, a stringent standards approach could have the effect of manipulating all three components of emissions class shifts -- new car purchase, retrofit equipment purchase, and maintenance. Probably, however, standards will have to be set at a fairly low level (see page 2-18) and for most cars will amount essentially to maintenance requirements, although some pre-1968 models may have need of a control device.

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[1] The problem of what to do about cars that cannot be brought into compliance with emission standards is largely unresolved. One source dismisses it as "one of the many 'sticky' operational problems that all states will face in developing inspection programs."

This problem arises only if the standards (on maximum allowable emissions) approach is used. If, as described on page 2-5, the standard of acceptability is defined as the lowest level of emissions attainable by a specific car, the problem is avoided (though at a cost in air quality). Similarly, a discriminatory tax approach would never face the prospect of banning cars from the road, but would simply charge the owner a large sum for the privilege of disproportionately contaminating the air.

Maintenance Requirement

A more direct approach to require maintenance of all cars would be to establish "the absence of engine faults that cause unnecessarily high emissions" as the standard of acceptability, rather than a certain level of emissions. As the developers of this new inspection logic claim, "when no pertinent faults exist, each engine is as good as repairing agencies can keep it and should be regarded as acceptable."[1] The test cycle developed to determine engine faults provides valuable diagnostic information for repair purposes. This approach is ideal for exploiting the potential of controlled engines and thus should become increasingly important in the future when a greater proportion of lower emitting engines are in use.

In the absence of periodic emission checking, policy makers could require motorists to have their automobiles tuned once a year.[1] As proof, a certificate of compliance could be issued by the servicing facility, and this would be required for annual registration. Most authorities agree, however, that mandatory maintenance requirements would severely overburden the servicing facilities of any state, and might even lead to a rapid growth in the numbers of inept service stations. The difficulty in providing emissions control maintenance for large numbers of cars will be aggravated if ongoing research indicates that mechanics not specifically trained in emissions reduction techniques are inadequate and training programs have to be introduced.[2]

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[1] E. L. Cline and Lee Tinkham, "A Realistic Vehicle Emission Inspection System" reprinted in The Search for a Low-Emission Vehicle, United States Senate Commerce Committee Staff Report (Washington, D.C.: 1969), pp. 30-40.

In order to reduce the burden on servicing facilities, measures are needed that will choose a certain proportion of cars for annual maintenance. One approach would be to base maintenance requirements on age of vehicle, while another would be to require maintenance whenever a car changes hands.

The aggregate reduction in automobile emissions resulting from general maintenance policies will not be as great as the reduction resulting from a selective maintenance requirement based on direct inspection.[1] However, the costs of administering any type of mandatory maintenance programs would probably be negligible compared to the cost of establishing emission checking programs.

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[1] One study shows that in the absence of governmental action only about one-third of all motorists normally get an annual tune-up. Look magazine survey reported in Ernst and Ernst, "A Study of Selected Hydrocarbon Emission Controls." U.S. Department of Health, Education and Welfare, July 1969.

[2] One objective of a federally funded demonstration project under way in New Jersey is to determine the degree to which mechanics need be trained specifically for pollution control. New Jersey Motor Vehicle Emission Inspection Project, December 6, 1966, to June 30, 1970. Described in Hearings of the Senate Subcommittee on Air and Water Pollution, 91st Congress, Second Session, Part 1, pp. 379-380.

Mandatory Retrofit Requirement

As discussed in Chapter 1, anti-pollution kits are currently available for retrofit on most pre-1968 cars. Despite the low cost of these kits (from $20-$50, including installation) and their advertised ability to cut pollution levels (up to 50 percent), initial evidence shows that motorists are reluctant to purchase this equipment.[2] Consumer demand might be stimulated if the Federal Government were to certify the effectiveness of retrofit devices (see p. 1-3). Partial cost subsidies in the form of an income tax deduction might also increase sales.[3] The establishment of national used car standards would effect the application of control devices and was recently considered by the Senate Subcommittee on

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[1] The choice of those vehicles with highest emissions as candidates for a tune-up is, of course, the special virtue of an emissions checking program.

[2] An intensely promoted two-month marketing test recently conducted in Phoenix by a major auto manufacturer revealed that only 528 of a possible 334,000 owners of pre-1968 cars chose to purchase the kit ($20), a ratio of less than 1 in 600. Cited in Ideas (Washington, D.C.: International Research and Technology, August 1970), p. 67.

[3] The actual tax saving, however, would probably be negligible. For a discussion of this point, see Institute of Public Administration, "Governmental Approaches to Air Pollution Control: A Compendium and Annotated Bibliography," A Report to the Office of Program Development, Office of Air Programs, Environmental Protection Agency, Washington, D.C., 1971, Chapter 6, "Cost Sharing" (especially pp. 6-18 ff.).

Air and Water Pollution.[1] However, ultimately, the Subcommittee stated that they "were unable to develop a feasible national system" for controlling emissions from used vehicles -- it is "a class of vehicles for which the regions and states have better opportunities to control."[2]

Precedent for state retrofit requirements can be found in California. The Air Resources Board of that state requires installation of used car control devices if they (1) meet certain emission reduction criteria, (2) are compatible with at least 75 percent of used cars in the State, and (3) cost less than $65. The cost to motorists of installing retrofit emission control devices on all pre-1968 model year vehicles (in 1973) is estimated to be $1.6 billion.[3] However, in view of the disproportionate share of the pollution attributable to pre-1968 vehicles -- in 1973 they will constitute 40 percent of the automobile population but will contribute 60 percent of total vehicle emissions -- this cost may be justified by the increase in air quality.

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1. Committee Print No. 1, August 25, 1970, Section 211, reprinted in Hearings before the Subcommittee on Air and Water Pollution, United States Senate, 91st Congress, Second Session, Part 5.

2. National Air Quality Standards Act of 1970, Report of the Committee on Public Works, United States Senate, September 17, 1970, p. 13.

3. At the present time, however, the law applies only to crankcase emission retrofit devices.

## Economic Incentives

In addition to direct regulation, economic incentives may also be used to induce consumers to shift toward use of vehicles in lower emissions classes. Using economic incentives, two major policy approaches are available: registration fees and new car sales taxes. A registration fee, for example, might be based on the emissions class of the vehicle and could be established either to supplement or to replace standards and/or other regulatory approaches.[1] In the absence of a state emission checking program, a new car sales tax could be imposed. Presumably it would be based upon the new car emissions data available from the Federal Government.

## Proposed Legislation

State level: California. **The California legislature has two bills pending which attempt to discourage the purchase of high emission vehicles through differential taxation. One bill applies higher annual registration fees to vehicles with larger engines;[2] this assumes that emissions per mile have a simple relationship to engine size as measured by cubic inch displacement. Table 2-1** shows the graduated taxation levels as a function of cubic inch displacement provided in the bill.

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[1] Currently most states have discriminatory registration fees based on vehicle weight, a vehicle characteristic associated with degree of potential road "damage". However, such fees are not designed to change consumer preferences, but to raise revenue for building and maintaining roads.

[2] State of California Legislature. Assembly Bill No. 1, 1970, Regular Session, January 6, 1970.

Table 2-1

CUBIC INCH DISPLACEMENT AND ANNUAL AMOUNT
OF REGISTRATION FEE OF MOTOR VEHICLES
(1971 OR LATER YEAR MODEL)

| Cubic Inch Displacement | Annual Licensing Fee |
|---|---|
| 0-199 | $ 30 |
| 200-249 | 40 |
| 250-299 | 50 |
| 300-349 | 70 |
| 350-374 | 90 |
| 375-399 | 110 |
| 400-424 | 140 |
| 425-449 | 180 |
| 450- | 250 |

A second California bill seeks to influence vehicle choice by using discriminatory taxation.[1] Specifically, the sales tax payable on a particular make and model would be determined by comparing its estimated average emissions of hydrocarbons, carbon monoxide, and oxides of nitrogen to the maximum limits for each of these pollutants under California law. The smallest, i.e., worst, of the three differences of estimated emissions to maximum standards would determine the amount of emissions sales tax. The tax levels provided in the bill are contained in Table 2-2.

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[1] State of California Legislature. Assembly Bill No. 2035, 1970 Regular Session, April 2, 1970.

Table 2-2

AMOUNT OF NEW CAR SALES TAX ON EACH MAKE AND MODEL OF VEHICLE BASED ON AVERAGE PERCENTAGES OF EMISSIONS STANDARDS

| Estimated Emissions as a Percentage of Maximum Standards | Tax on the Sale of New Motor Vehicles |
|---|---|
| Less than 50% | No Tax |
| 50-60% | $ 40 |
| 60-70% | 90 |
| 70-80% | 150 |
| 80-90% | 220 |
| 90-100% | 300 |

Federal level. At the federal level, there has been little consideration given to similar measures. There have been two bills introduced in the House of Representatives seeking to make federal excise taxes a function of engine horsepower and pollution (see p. 1-18). Such taxes, although levied on manufacturers, will probably reduce the demand for larger cars (rather than the supply) because of their incidence.

The most significant automobile-related federal legislation attempting to use a discriminatory taxing mechanism was the recent Administration proposal to put a tax of $4.25 on each pound of lead additive that is blended into gasoline. The main purpose of this tax was not revenue, but the creation of an inducement that would speed the process toward low-lead or lead-free fuel by making such fuels competitive with the less expensive, leaded fuels.[1]

Problems. A serious shortcoming in some of the legislation above is the lack of precision with which vehicles were placed in emissions classes. In the first piece of legislation described, registration fees were based on cubic inch displacement as the sole index of pollution potential. However, many other vehicle characteristics such as maintenance, horsepower, number of cylinders and type of transmission also determine the quantity of contaminants emitted. The use of engine size (or horsepower in the case of the federal legislation mentioned), although a strong indicator of relative emission levels, represents a drastic over-simplification.[2]

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1. See also p. 1-31. An extensive discussion of the lead tax (as an economic incentive) may be found in Institute of Public Administration, "Governmental Approaches to Air Pollution Control: A Compendium and Annotated Bibliography," A Report to the Office of Program Development, Office of Air Programs, Environmental Protection Agency, Washington, D.C., 1971, pp. 7-20 to 7-24.

2. One disadvantage is that it provides no information about some important pollutants for in-service vehicles. ". . . cubic inch displacement and several other engine characteristics are not significantly related to exhaust emissions of oxides of nitrogen or hydrocarbons." Ralph d'Arge, Truman Clark, Osman Bubik, Auto Exhaust Emissions Taxes: Methodology and Some Preliminary Tests, Project Clean Air, Research Project S-12 (University of California: September 1, 1970), p. 19.

This defect could be remedied by placing vehicles in emissions classes on the bases of actual measurement, rather than by use of non-representative surrogates. Alternatively, if estimation techniques could be perfected, automobiles could be placed in emission classes on the basis of vehicle characteristics.

Estimation. A group of California economists recently attempted to identify and weigh the vehicle characteristics that would predict the observed variation in vehicle emissions. Although they statistically examined a large number of vehicle characteristics (e.g., weight, average fuel consumption, engine size and/or horsepower), which appear to be highly correlated with average emission rates, they were unable to arrive at equations which would explain much of the variation in observed emission rates among vehicles.[1]

Economic considerations. In both of the California bills, the specific tax schedules provided are quite arbitrary; no attempt was made to relate the fees for specific emission classes to the proportional share of pollution caused by that class. Since estimates of pollution damage are subject to controversy, different but internally consistent tax schedules could be developed depending upon the particular dollar value of damages estimated for each ton of automotive emission:

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[1] Ralph d'Arge, Truman Clark, Osman Bubik, Auto Exhaust Emissions Taxes: Methodology and Some Preliminary Tests, Project Clean Air, Research Project S-12 (University of California: September 1, 1970).

> . . .if a ton of gaseous residuals is assumed to cause $1.00 or $10.00 in social damages, the absolute magnitude of tax by vehicle type will change, but the degree of proportional discrimination will not change. Motor vehicles with higher amounts of "potential" emissions will be taxed at higher rates, but the relative differentials between high and low polluting vehicles will remain constant regardless of the dollar amount of damages per ton of pollutants that is assumed.[1]

Although an improvement over arbitrary tax schedules, such a schedule would be equitable only if automobile usage (e.g., miles driven per year) and location of predominant use (e.g., urban driving), the other key components in determining pollution damage, vary approximately the same within each class. But these assumptions appear unrealistic. A certain class of vehicles, for example, may be driven primarily for excursions in the country, in which case the tax associated with its class would overstate the class's proportional contribution to air pollution damage and hence overcharge the owner. Consequently, in the absence of any hard data to the contrary, the assumption that usage and location vary equally for each class of vehicles appears to be untenable.[2] Similarly, there are equity problems for individual motorists whose usage habits differ from "average" habits.

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[1] Ralph d'Arge, Truman Clark, Osman Bubik, Auto Exhaust Emissions Taxes: Methodology and Some Preliminary Tests. Project Clean Air, Research Project S-12 (University of California: September 1, 1970), p. 11.

[2] It could be argued, of course, that the average payment for each class of vehicles would probably be equitable. However, although each class as a group would probably pay its proper share, almost certainly most individual owners would not. For instance, car owners using their vehicles exclusively in the country or well ventilated areas would be overpaying as would "weekend" drivers. In short, equitable treatment will not be accorded to those whose automobile usage habits vary significantly from "average" habits.

These inequities might be alleviated by developing tax schemes which relate emission classes to location of emissions or to intensity of automobile usage, or preferably, to both. Such schemes are discussed in detail in Chapter 5, "Emission Charge Systems".

Political considerations. A difficult political choice will be posed if discriminatory registration fees are to be applied to the registration of all cars. To the extent that older, high pollution emitting cars are generally owned by poorer individuals, such a tax would tend to be regressive. This impact could be mitigated by adjusting the tax schedule for age of vehicle -- a two-year old automobile in a certain emissions class would pay a larger tax than a four-year old vehicle with identical emissions. At the same time, of course, adjustments of this sort will reduce the incentive to dispose of older cars and purchase a new car or retrofit equipment.

## State Emission Checking Programs

Up to this point, the approaches to auto air pollution control have been discussed without regard to the desirability of establishing a state auto inspection program for auto emissions. This section will describe some of the basic considerations surrounding a state's decision to introduce such a program.

Ideally, the decision to establish a costly emission checking program would be based on projections of the needed reduction in aggregate emissions in a particular state to maintain healthful air quality levels. Once this goal is established, policy makers would compare costs and benefits of policies available with an inspection program and policies available without such a program. Table 2-3 summarizes the major policy alternatives aimed at consumer control of average emissions per mile which are available both with and without an emission checking program. In general, policies aimed at regulating emission classes require knowledge of emission ratings, while measures directed at specific components of emissions classes do not.

Table 2-3

POLICIES AIMED AT CONSUMERS TO CONTROL AVERAGE EMISSIONS PER MILE

| With Emission Checking Programs | With or Without Emission Checking Programs |
|---|---|
| 1. Standards | 1. Mandatory Maintenance Requirement |
| 2. Selective Maintenance | 2. Mandatory Purchase of Retrofit Equipment |
| 3. Discriminatory Registration Fee | 3. Discriminatory New Car Sales Tax |

This categorization facilitates systematic comparison of policy alternatives. For example, making one comparison, it is quite possible that requiring the purchase of retrofit equipment -- if such devices actually meet manufacturers' claims (see fn. 1, p. 2-3) -- may be more cost effective than establishing a state-wide emissions inspection program using standards. However, the latter will result in a larger aggregate amount of reduction although the cost per unit weight will be higher than with the retrofit device approach. Policy makers should attempt to make precisely such comparisons for policies and combinations of policies available both with and without inspection programs before embarking upon such a costly course of action as establishing a state-wide system for auto emission inspections. This will not be an easy task for the costs and benefits of emission checking programs are highly uncertain.

Costs. The cost of establishing an emissions checking program (including equipment) for the entire United States is estimated to be more than $100 million. The cost would vary from state to state depending upon whether or not the emissions program will be added to an existing safety inspection program, or be the focus of an entirely new program.[1] The cost will also depend upon the way in which the program is administered -- at state-operated facilities, at state-appointed service stations, or by random spot checks.[2] The latter will be the least costly of programs, but will result in the smallest decrease in aggregate emissions, as this criterion is directly related to the proportion of vehicles tested. The organization of the program will determine to a large extent which of several possible types of test equipment and evaluative routines can be efficiently employed.

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[1] Currently 31 states (and the District of Columbia) have periodic motor vehicle safety inspection programs, and seven states have some form of random spot inspection.

[2] Of the 32 jurisdictions that have periodic inspection programs, 29 operate under a state-appointed system. Only three jurisdictions have central, state-operated inspection facilities.

Federal funds are available to states under the Air Quality Act of 1967 for partial support of almost all phases of establishing and operating an emission checking program: program development (two-thirds grants, Section 209); training and demonstrations (Section 103(a)(2)) and (b)(3)); instrumentation (Section 104(b)(1)); program maintenance (Section 105(a)).[1]

Benefits. The amount of reduction in emissions will be determined by the accuracy of the test procedure and the level at which the rejection rate can be set (assuming a standards approach will be used). Evidence indicates rejection rates will have to be lower than 20 percent[2] or perhaps 40 percent[3] in order to prevent a critical overload of commercial repair facilities and eliminate the heavy burden on the inspection system that would occur in the way of demands for a retest. Also making accurate estimation of benefits difficult, there is great uncertainty concerning the amount of emission reduction possible from post-1970 model vehicles. However one fact is clear: the cost per ton of reduction for composite emissions increases with time. This occurs because costs are increasing while potential emission reductions are decreasing. Costs will increase simply because vehicle population increases and more tests and repairs are therefore required. Potential emissions reductions will decrease because the federal standards strategy (as outlined in Chapter 1) will drive down the base levels of emissions.

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[1] The Clean Air Act Amendments of 1970 renumbers as well as makes minor modifications in some of these provisions.

[2] Ernst and Ernst, "A Study of Selected Hydrocarbon Emission Controls", U.S. Department of Health, Education and Welfare, July 1969.

[3] Marian F. Chew, "Auto Smog at Idle Only," Society of Automotive Engineers, No. 690505, May 1969.

Another uncertainty about benefits is the extent to which motorists will deliberately alter the emission levels of their cars. If checking is done on a scheduled basis, some motorists might not scruple to have their engines fine-tuned in order to pass the test, and then have them retuned for maximum performance regardless of the accompanying increase in pollution. Furthermore, since pollution control systems would probably be external to the engine, it would be a simple matter to disconnect the system after passing the test.[1] Less extensive engine readjustments (e.g., manipulation of the fuel-air mixture) could also have a major impact on the engine's emissions. Although an emissions checking program would probably curb many such abuses, deliberate avoidance of proper classification on the part of those determined to do so could not easily be prevented until a better monitoring system becomes available than is now in existence. Under present conditions, the appeal of deceptive practices could be reduced by sealing the carburetor at the time of inspection, instituting random spot checks, or imposing fines where the results of spot checks revealed a significant increase above a previously recorded emissions level.

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[1] The Federal Government and the State of California have laws prohibiting manipulations of pollution control systems that render such systems less effective. However, the effects, if any, of this legislation are not clear.

To sum up, the attempt to obtain an accurate estimate of the aggregate pollution reduction resulting from the creation of a statewide emission checking program is a highly uncertain process -- it involves forecasting the nature and cost feasibility of future monitoring technology, future automobile emission characteristics and the behavior of motorists.

Current status. Although a careful evaluation of the need for establishing formal emission inspection programs on a state by state basis is lacking, there is strong Congressional pressure for states, especially those with severe air pollution problems, to establish such programs. At the present time, however, no state has applied for the two-thirds grant for developing emission inspection programs, largely because of problems with measurement technology. Seeking to eliminate this roadblock, the Federal Government made a grant to the State of New Jersey to support the development of emissions testing procedures for state programs.[1] A "quick" cycle emission testing procedure was developed during the course of this demonstration project. Although this test procedure is rapid (90 seconds) and inexpensive, doubts may be expressed about its accuracy.[2] Accelerated federal-supported research will probably soon result in the development of a quick, reliable, and cheap test. Then federal and public pressure will probably cause most states with air pollution problems to incorporate emissions testing into their periodic safety inspection programs,[3] or, alternatively, to establish independent emission programs.[4]

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1. New Jersey Motor Vehicle Emission Inspection Project, December 6, 1966-June 30, 1970. Described in Hearings of the Senate Subcommittee on Air and Water Pollution, 91st Congress, Second Session. Part 1, pp. 379-380

2. In general, most "quick" cycles rely on the unproven correlation between the results of tests on a few modes of engine operation and the results of tests on the full seven-mode Federal cycle. Although "average correlation" may be excellent, there is significant doubt about vehicle by vehicle correlation.

3. All states currently have plans for periodic state inspections in order to quality for federal highway construction aid.

4. The Clean Air Act Amendments of 1970 require that states include in their air quality implementation plans provision for periodic emission checking of motor vehicles "to the extent necessary and practicable." P.L. 91-604, Section 110(2)(G).

# CHAPTER 3

## CONTROL OF MILES DRIVEN PER YEAR

In the preceding two chapters, discussion focused on governmental approaches to reduce average automobile emissions per mile of use. This chapter will consider policies which can limit the number of miles of private automobile use. This will be especially important since automobile usage is expected to grow rapidly for the remainder of this century. According to APCO estimates, annual automobile miles will increase from 838 billion in 1970 to 989 billion in 1975. If this 3 percent annual rise continues, automobile usage will increase by billions of miles in the near future. As a result, the aggregate number of miles driven per year will assume an increasingly important role as a producer of auto air pollution.

A significant reduction in annual miles driven essentially implies moving away from an automobile-centered society. This, of course, raises difficult cultural questions as well as political and economic ones. With regard to the latter, a significantly reduced dependence on the private automobile is likely to have major economic repercussions.[1]

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[1] The manufacture of motor vehicles and parts is the largest industry in America -- first in sales, first in employment and first in payrolls. Automobile manufacturing and distribution and automotive transportation provide some 15 million jobs (28 percent of private non-farm employment). Furthermore, each car and truck manufactured and sold in the United States generates $1,200 in taxes, and these taxes provide 5 percent

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Consequently, attention here will be on the possibility of making "modest" inroads in reducing automobile use or, perhaps, reducing the rate of increase of automobile use. Achieving either of these goals could result in noticeable air quality gains in the next few years because of the high proportion of pre-controlled and partially controlled cars that will be on the roads. Furthermore, small reductions in automobile use in specific urban locations could greatly mitigate pollution damage.

It should be realized that fundamental changes in the way private transportation needs are being met are being sought for many other reasons besides air pollution considerations. The quality of transportation affects the economic efficiency of cities and the life style of city dwellers as do few other services. The fact is, however, that certain groups (the young, the old, the poor, the incapacitated) are not well served by automobile-centered transportation systems. Furthermore, automobiles co-opt huge amounts of valuable urban space, especially in high density business areas with large concentrations of high rise buildings. The omnipresent congestion in such areas (as well as others) causes huge losses in time for millions of people daily, not to mention the accompanying fatigue and

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of the total tax revenue of all units of government.
Source: Statement by L. A. Iacocca, Ford Motor Company, September 9, 1970. Reprinted in Hearings before the Subcommittee on Air and Water Pollution, United States Senate, 91st Congress, Second Session, Part 5, pp. 1608-1627.

nervous strain. Thus, decisions on measures to limit automobile use presumably would include evaluation of a broad spectrum of cost and benefits -- air pollution being only one consideration, albeit a high priority one. Although reference will occasionally be made to the broad implications of various policy approaches, this chapter will devote almost exclusive attention to the air pollution aspects of limiting automobile use.

Direct approaches to reduce miles driven can be classified into two basic categories: direct controls over vehicle use and imposition of a tax or other price control related to vehicle use. Within these general categories, consideration will focus both on measures to reduce *aggregate* miles driven and measures which can reduce automobile use *specifically* in congested urban areas.

Mass transit -- to the extent that it may have potential to displace automobile use -- will also be discussed as an indirect approach to reducing miles driven. In addition, consideration will be given to enlightened urban design, which through alteration of the basic spatial relationships between people and activities, [illegible] possibly reduce average trip length and also make economical mass transit systems possible.

## Vehicle Use Controls

### Direct Regulation

Direct control over the aggregate number of miles per year motorists drive generally implies some sort of rationing -- most likely fuel rationing. To limit automobile use in congested urban areas, rationing road use, parking spaces and rights of way (to high occupancy vehicles) could discourage private automobile use in these critical areas.

Fuel and vehicle rationing. Controlling the consumption of automobile fuel via a rationing mechanism could result in a rapid decrease in automobile use. However, in the absence of widespread health disasters attributable to pollutants from automobiles, it is highly unlikely that such a large intrusion of government into the private sector would be deemed politically feasible or desirable. The severe economic repercussions caused by rationing, the difficulty in providing equity, and the enormous cost of enforcement also mitigate against adoption of such a policy. Instead, for cases of prolonged catastrophe or in order to prevent localized emergencies from spreading, direct restrictions on the location of automobile use will generally provide a more desirable alternative.

In view of the increasing trend toward multi-car households,[1] limiting the number of automobile registrations per household provides another alternative to reducing miles driven. Although probably easier to enforce than fuel rationing, it has the same serious shortcomings.[1]

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[1] Twenty-nine percent of all U.S. households in 1969 owned two or more cars, an increase of 10 percent from 1961. When compared to car-owning households, the number of multi-car households is considerably larger -- 36.5 percent.
Source: Estimated by Automobile Manufacturers Association from U.S. Department of Commerce, Bureau of the Census, Population Characteristics (Series P-20) and Consumer Buying Indicators (Series P-65). Cited in 1970 "Automobile Facts and Figures", Automobile Manufacturers Association, p. 47.

Traffic bans. Direct restrictions on location of permissible vehicle operation could discourage automobile use if such restrictions were sufficiently extensive to make driving inconvenient (or impossible). Small scale traffic bans may very well serve only to alter traffic patterns rather than reduce vehicle use. Since bans must be viewed as an approach to control the location of vehicle use, this concept will be discussed at length in Chapter 4.

Parking restrictions. Limitations of on-street parking when paired with strict enforcement can discourage motorists from taking their cars into the downtown area. In New York City, each week some 1,000 motorists have their illegally parked vehicles towed away, resulting in a $75 fine.[2] Allocating the existing parking spaces to city residents would make parking increasingly difficult for those living in outlying districts. Boston, for example, now limits all nighttime street parking to city residents who display a special sticker on their windshield.[1]

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[1] The New Jersey Clean Air Council recently considered this measure but had doubts about the "fairness or even the constitutionality of such control." See "The Report of the New Jersey Clean Air Council on the Status of Air Pollution from Mobile Sources" (July 1970), p. 31.

With the risk of pushing an analogy too far, it would seem that steps should be taken with respect to automobile ownership similar to those used to instruct the public in the virtue of limiting the size of families. Partially as a result of widespread publicity, it is widely felt that more than two children adds to the overpopulation problem, but seldom is any consideration given to the environmental consequence of owning two or three cars!

[2] "The Ban-the-Car Movement," in Newsweek (January 4, 1971), p. 42.

Preferential lanes. Separate lanes for buses (see below) and cars with more than one occupant could increase average trip speed and thus provide impetus for mass transit ridership and car pool formation.

## Financial Incentives

Cost per mile is a factor which undoubtedly can influence motor vehicle use. However, in comparison to the large sunk cost involved in automobile ownership, operating costs generally tend to be small and are thus often overlooked by automobile owners. But if the cost per mile of driving were to increase substantially, motorists would probably attempt to use each mile of driving more efficiently by such practices as the formation of car pools, less frequent shopping or short pleasure excursions, using mass transit[2] and the like.[3]

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[1] "The Ban-the-Car Movement," in Newsweek (January 4, 1971), p. 42.

[2] Researchers have found, however, that price differentials may have only a limited effect. "The point of equilibrium between automobiles and mass transit does not seem to be the economists' dollar point, but the perception of that point by the individual user through the values he has acquired by using the automobile, the way it has affected his experience, his range of choices and preferences." Ibrahim M. Jammal "Vehicular Air Pollution: Variables Influencing the Urban Transportation System" in Air Quality Standards, Arthur Atkisson and Richard S. Gaines, Ed. (Columbus, Ohio: Charles E. Merril, 1970), p. 131.

[3] The major benefits of applying price controls to vehicle use may be longer term. As noted above, the additional costs of use will probably be small relative to the purchase price of the car, and, hence, may not have short run impact. However, such controls (with suitable mass transit available) may mitigate the increasing trend toward multi-vehicle ownership as the cost of having a second (or third) car increase significantly. Although, on average, a one-car family will make more intensive use of the family automobile, the amount of miles driven will generally be considerably less than the amount driven by families owning more than one car.

Direct usage tax. In the absence of sophisticated monitoring devices to measure individual automobile use reliably and inexpensively, a surrogate for miles driven must be employed.[1] Since there is a direct correlation between number of miles driven and fuel consumption, taxes on fuel sales would appear to be one of the most efficient means of inducing a reduction in the aggregate number of miles driven. The degree to which a tax on fuel can reduce automobile usage is related to the size of the tax and the sensitivity of consumer demand to price increases.[2]

A tax on fuel for this purpose, however, has certain problems. First, since taxes on fuel account for approximately 30 percent of the cost of fuel, the reaction to additional taxes by both the petroleum interests and the motoring public would probably be particularly negative. Second, a tax on fuel would not be an efficient or equitable approach to reduce pollution damage (as distinct from pollution magnitude). A simple fuel tax implemented to reduce air pollution essentially represents the air polltuion damage from driving an "average" automobile in an "average" location. However, since it does not discriminate on the basis of the vehicle for which the fuel was purchased, such a fuel tax would neither charge the owner of a high (or low) emission vehicle for his disparate share of the pollution, nor would it provide any incentive to drive lower emitting vehicles. In addition, and more important for the discussion here, a simple fuel tax, by not discriminating on the basis of location of use, will tend to reduce automobile usage uniformly in all areas. The cost to society of a given quantity of automobile emissions, however, is directly related to the location in which the vehicle is operated -- in general, the greater the existing level of pollution, the greater the damage that will be caused by an incremental amount. Thus, a more efficient and equitable policy would discriminate on the basis of location of miles driven and assess charges to individual motorists according to the estimated air pollution damage of a trip of given length in a specific location.[1]

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[1] The possibility of direct monitoring of vehicle use will be discussed in Chapter 5.

[2] One study has found consumer demand for automobile fuel to be relatively inelastic, that is, generally insensitive to increases in price, especially in the short run. H. S. Houtthaker, L. D. Taylor, Consumer Demand in the United States, 1929-1970 (Cambridge, Mass: Harvard University Press, 1966).

## Other Financial Incentives

Various other financial incentives are available to discourage private automobile use, especially for transportation in downtown areas. These incentives include parking taxes, commutation taxes, and tax rebates for car pool drivers.

Parking taxes. Heavy parking taxes could discourage automobile use in congested areas. San Francisco, for example, has imposed a 25 percent tax on parking fees in private garages. Similar in result to parking taxes, the reduction or elimination of the generally heavy indirect subsidy to motorists who park in major urban areas would doubtless result in a large increase in parking costs. Such policies, however, tend to penalize local traffic for using downtown road space, while exempting through traffic from this financial burden. These policies also require that transportation alternatives be provided concurrently, or else parking becomes a rich man's luxury.

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[1] An ideal policy would discriminate on magnitude of emissions in a given location. Miles driven is only one component of emission magnitude -- the other being the emission characteristics of the source (emission class). This concept will be treated in greater detail in Chapter 5 where such a "complete" emissions charge system is developed.

Commutation taxes. Cities with limited access routes such as New York could impose heavy tolls at bridges, tunnels, and highways leading into the city. This toll could be based on vehicle occupancy in order to promote car pools. Clearly, however, this measure cannot be used where access to an urban area is not confined to bridges and tunnels. And even in New York, the implementation of this meausre would require installation of expensive toll collection stations at each point of entry.

Tax rebates. As a stimulus to car pool formation, a number of proposals have been made in state legislatures (noticeably California) to forego gasoline taxes and taxes on parking fees for car-pool drivers. The administrative feasibility of tax rebates or exemptions is questionable, as it is not clear how car-pool ridership could be validated for such purposes.

## Mass Transit [1]

Perhaps the most profound reduction in automobile miles driven could be achieved by fundamental changes in the way private transportation needs are met. At present, urban transporation systems

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1. The authors wish to express their appreciation and thanks to Sumner Myers and Joseph Revis of the Institute of Public Administration for their insights on the interface between air pollution control and transportation policy.

in most U.S. cities rely primarily on the private automobile.[1] Mass transit, however, offers the possibility that automobile usage could be reduced, especially for commutation to work which accounts for approximately 50 percent of all automobile trips.

Historical Federal Transportation Support

Heretofore, the strategy for meeting the nation's transportation needs has been dominated by new highway construction. The state and local commitment to highways is attributable, in large measure, to the lucrative federal aid for highway construction -- the Federal Government furnishes 90 percent of the money to build the money to build the Interstate Highway System, the states only 10 percent. The huge sums of interstate money, as well as the 50-50 matching funds of other federal-aid highway programs, have lured -- if not forced -- cities and states into emphasizing highways over mass transit.

The Highway Trust Fund, created by Congress in 1956, was originally established to build the interstate system, but it is now also the source of all federal funds for federal-aid primary and

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1. On a national basis, for example, 82 percent of commuting workers use automobiles as a means of transport while only 14 percent use public transportation. U.S. Department of Commerce, Bureau of the Census, "Home to Work Travel Survey", reprinted in 1970 Automobile Facts and Figures, Automobile Manufacturers Association.

secondary roads. Although the Fund has a huge annual influx of revenue,[1] and contains most of the federal money available for transportation of any kind, it is dedicated solely to highway construction.[2] Consequently, federal support for mass transit (approximately $600 million between 1964 and 1970) has been meager in comparison to the annual federal outlay for highway construction (approximately $4 billion annually).

Increased highway construction, in conjunction with the apparent public preference for the speed, comfort, and convenience of the private automobile has generated additional traffic which in turn has led to a need for more highways. As a result, urban mass transit is caught in a cycle of increasing costs and fares, and decreasing quality, traffic, and profits.[3] Recent legislation, however, as well as legislative proposals and statements of government officials indicate the tide is turning toward drastically increased federal support for

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1. The Fund currently has a claim on about 71 percent of all federal excise taxes related to highway use, including the 4¢ per gallon motor fuel tax. Revenues to the Fund in Fiscal 1969 totaled $4.7 billion. An increase in this amount to some $5.4 billion is expected in 1971 as tax revenues rise. Data cited in Conservation Foundation Letter (Washington, D.C: June 1970), p. 3. Legislation also has been introduced to increase the revenue flowing into the Fund. One bill introduced in a recent session of Congress would have turned over to the Fund all revenues from the 7 percent excise tax on automobiles (approximately $1.9 billion annually). H.R. 16604 (Findley), 91st Congress.

2. Recent legislation has "opened" the Fund slightly to permit funding of certain highway related projects other than construction. There is increasing pressure for legislation to permit the Fund to be used for general transportation purposes. See pp. 3-19 to 3-21.

3. Passenger volume on mass transit systems fell by some 54 percent between 1950 and 1969, while it is estimated that mass transit systems lost nearly $300 million over the last five years.

construction, improvement, and possibly even subsidy of mass transit system operating costs.

Before examining the current outlook for federal support of mass transit systems, it will be meaningful to examine the potential of mass transit systems to displace automobile use. Since present concepts offer the most immediate payoff, new construction of rail systems and improvements to existing rail and bus systems will be considered first.[1] Discussion will then turn to several radically new mass transit concepts (e.g., dial-a-bus systems) which will be made possible by breakthroughs in urban transportation technology.

Rail. Although rail systems have demonstrated a capacity to effect a shift in the transportation mode from automobiles,[2] this form of mass transit appears to have only slight promise for air quality improvements on a national basis. At present, fewer than two dozen cities have the kind of high density channel demand effectively served by rail.[1] In the overwhelming majority of cities, the spatial arrangement of activities is such that most potential riders would be going where the rail system would not. This is especially true of the potential of rail systems "in the other direction", i.e., carrying center city residents to suburban jobs. Surveys indicate that neither the new rail system planned for Washington, nor the new San Francisco system (see below) will effectively accomodate the transportation needs of inner city residents who work in outlying areas. Nor do rail systems linking suburbs and central cities provide for non-radial trip needs from suburban areas where population and employment are growing most rapidly.

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[1] One expert feels too much effort is being concentrated on futuristic schemes with a concomitant neglect of the short range potential that can be realized within three to five years by focusing on existing concepts with existing technology. See Sumner Myers, "Technology and Urban transit", Business Horizons (Spring 1967).

[2] A high speed rail project instituted a few years ago from the village of Skokie to downtown Chicago resulted in shifting approximately 2,000 daily auto trips to mass transit facilities. The automobile and Air Pollution, A Program for Progress (U.S. Department of Commerce: October 1967), p. 33.

More recently, the New Jersey State Department of Environmental Protection reports that the "dramatic increase in ridership on the PATCO lines between Linden Wald (New Jersey) and Philadelphia has shown quite clearly that passenger car commuters can be attracted by rapid, convenient, economical, and comfortable rapid transit systems." Report of the New Jersey Clean Air Council on the Status of Pollution from Mobile Sources (July 1970), p. 19.

What is more, rail transit may actually alter the spatial arrangement of activities in the urban environment to the detriment of pollution control. There is evidence that rail improvements accelerate decentralizaton of urban areas. and consequently increase average trip length and the need for automobile use to serve low-density, non-radial trip demands. Also, the lessened congestion in downtown areas associated with rail improvements may be short lived. Areas surrounding the terminal are quickly developed and, attracted by lessened congestion, automobile use in the area may actually increase. Hence the net gain in downtown air quality from rail improvements may be eliminated.

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[1] Currently only New York, Chicago, Philadelphia, Boston, and Cleveland have rail transit. New rail transit systems are being built in San Francisco and Washington, D.C.

In sum, although rapid rail systems are often advocated as a means of easing congestion and reducing air pollution, there appears to be little evidence to support either of these contentions. For this reason, careful attention will be focused on San Francisco's Bay Area Rapid Transit (BART) system which is the epitome of a modern rapid rail system. If BART's patronage, revenues, and earnings measure up to expectations when it begins service later this year, it probably will serve as impetus for increased federal funding of rail systems. With substantial federal support, approximately six cities (Seattle, Baltimore, Los Angeles, Atlanta, St. Louis and Pittsburgh) could be expected to get new systems under way. Before such evidence is gathered, new rail systems probably should be viewed as a long term, high-cost (first-stage BART will cost about $1 billion), high risk approach.

Bus. In contrast to rail, bus and other mass transit designs capable of economically serving a relatively low channel density have more recognizable potential in most cities to shift transportation demand away from the private automobile.[1] The primary reasons buses have not realized more of this potential is related to three factors:

1. The vehicle itself is frequently unpleasant and uncomfortable.

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[1] In some cities, however, origins and destinations will be so scattered that fixed route bus systems will not be economical since buses require fairly high average occupancy because of the high labor costs.

2. Routes and schedules often are poorly adapted to changing travel demands as well as insufficiently publicized.

3. Buses (as they are now operated) are hapless victims of urban congestion.

The first factor can be remedied rather easily by vehicle redesign and the second by well-established analytical techniques and publicity campaigns. However, remedial action with respect to the third factor is much more difficult; a minimum requirement is that buses be given priority over private cars in entering and using highway and street systems. This implies the creation of exclusive "bus lanes", the organization of reserved loading and unloading zones and a priority system for buses at intersections. The provision of exclusive lanes on highways has proved successful in reducing trip times and in increasing ridership,[1] but it may prove extremely costly and politically difficult to establish priorities for buses in city areas. In this case, the most effective way of increasing bus ridership will be to get all traffic to flow faster. Since increasing average speed will also reduce source emissions, this result would have a two-fold benefit.

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[1] In an ongoing experiment, one lane of Shirley Highway into Washington from suburban Virginia has been reserved for buses. Initial data show that commuting time has been cut 30 minutes from outlying districts and ridership has increased 19 percent.
Source: "The Agony of the Commuter", Newsweek (January 18, 1971), p. 48.

As information in the following chapter indicates,[1] the application of planning techniques and flow control technology will probably be able to greatly increase average speed. If such is indeed the case, and priority treatment is given to buses so that they maintain a relative advantage over automobiles, bus ridership will probably increase with a concomitant decrease in automobile miles driven.

New mass transit concepts.[2] Several technological innovations designed to meet specific transportation needs hold out promise to reduce the dependence on the private automobile. For example, the taxi-bus (sometimes called "dial-a-bus") system, can service the demand for non-radial, low density traffic which at present can only be met economically by the automobile. This is a computerized mini-bus system which utilizes sophisticated monitoring and dispatching technology. Consequently, in theory, door-to-door service can be provided in a multi-passenger vehicle at a cost considerably lower than the standard taxi.[3] This taxi bus concept will be field tested this year in Rochester, N.Y., and Haddonfield, N.J.

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[1] Since increasing average speed is an important policy consideration in urban areas, it will be discussed in the following chapter. Of particular relevance to the discussion here, is the consideration given to coupling flow control technology and bus priorities. See pp. 4-5, 4-6.

[2] This section will only briefly consider a few new mass transit concepts that have potential to reduce automobile use. For a comprehensive look at the shape of mass transit in the future, see Tomorrow's Transportation (Washington, D.C.: U.S. Department of Housing and Urban Development, May 1968).

[3] The fare for a given trip, however, may actually be greater than the operating cost of automobile use because of the high labor cost associated with small capacity, chauffeur driven vehicles.

"People movers", a term generally applied to smaller than streetcar vehicles that can carry people around small cities, large airports, and peripheral parking areas, are another promising innovation. These vehicles are usually computer programmed to conform to the traffic flow. This feature highlights the major problem with people-movers (beyond the opposition of bus and cab companies): it is extremely difficult to program the special demands of individual users into the general traffic flow. This, of course, is a necessity if people are to be persuaded to abandon their private cars. The Urban Mass Transit Administration is currently funding a full-scale test of a people-mover system at Morgantown, West Virginia.

In addition to cleaner air resulting from a reduction in automobile usage, there is the likelihood mass transit systems will be moved by inherently low polluting power plants. Design requirements for unconventional mass transit power plants are often far easier to meet technically than they are for private automobiles. In contrast to the state of low emission automobile technology, the development of low polluting mass transit technology is well advanced.[1] Gas turbines, for example, are being field tested for installation on buses, although preliminary evidence indicates their potential for passenger cars may be limited.[2]

Summary and conclusions. Although in most cities buses have relatively more potential than rapid rail systems to reduce automobile use, it remains an open question as to how much impact such mass transit modes can have. On the basis of past experience, many experts believe that new and improved bus and rail systems can induce only a minimal shift away from the private automobile. A recent study concluded that alternatives to the car usually do not help: "Rather, the inevitable increase in traffic seems to halt only when it is discouraged by congestion."[1] However, as mass transit gets revitalized by substantial funding, "puts on its fancy clothes" and provides quicker and more comfortable service, this conclusion may be subject to modification. In addition, mass transit may be in for a sizable boost as more and more localities apply financial incentives and vehicle use controls to discourage private automobile use (see above). Furthermore, new mass transit concepts appear likely to fill important gaps in existing mass transit capabilities.

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[1] The Urban Mass Transportation Administration (DOT) has begun a series of research projects aided at exploring the potential of unconventional, low pollution systems. One ongoing demonstration project, for example, is investigating the feasibility and desirability of steam buses.

[2] See Report of the Ad Hoc Panel on Unconventional Vehicle Propulsion, Office of Science and Technology (Washington, D.C.: March 19, 1971), p. 3.

As indicated earlier, mass transit must be judged in a broader context than as a partial solution to the auto air pollution problem. The introduction of mass transit would constitute a disturbance in an existing "ecological system" with highly uncertain ramifications:

> Many considerations are involved such as costs and benefits at the local and national levels ensuing from economic readjustment to new movement systems, questions of value pre-references of people and styles of life, economic adaptability of investments in existing environments which are automobile oriented, as well as political overtones reflecting anticipated economic and labor adjustment (not to say obsolesence).[2]

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[1] Setting National Priorities,(Washington, D.C.: The Brookings Institution) cited in "Conservation Foundation Letter" (June 1970), p. 5.

[2] Ibrahim M. Jammal, Vehicular Air Pollution: Variables Influencing the Urban Transportation System in Air Quality Standards, Arthur Atkisson and Richard S. Gaines, Ed. (Columbus, Ohio: Charles E. Merril, 1970), p. 127.

## Outlook for Mass Transit

Funding. Although there has been increasing interest over the past several years in "balanced" transportation systems, federal aid, as indicated above, has been inadequate to finance significant mass transit improvements, let alone major new construction. However, two pieces of legislation recently signed into law indicate a trend is developing toward substantially increased federal support of mass transit systems. In the Urban Mass Transportation Assistance Act of 1970, Congress pledged $10 billion over a twelve-year period for mass transit purposes. After state and local governments contribute their share, this figure may well rise to about $30 billion. Most of the funds available for the next five years ($3.1 billion) is expected to go for new buses, subway cars, and equipment.

In a more subtle fashion, The Federal Highway Act of 1970 represents a change in federal policy that may be indicative of dramatically increased support for mass transit in the future. This legislation -- for the basic purpose of extending the Highway Trust Fund -- was surrounded by heated debate. Conservationists, environmentalists, and urban planners argued that the Highway Trust Fund must be made available to finance a variety of approaches to combat urban congestion and vehicular air pollution. Backers of the Fund (including Members of Congress, highway builders, the petroleum and trucking industries, and state highway officials) steadfastly opposed diversion of the Fund from what they claimed is its only purpose -- highway construction. As enacted, the legislation represents a compromise between these opposing forces in two ways, both particularly favorable from the standpoint of mass transit. First there is a shorter than usual commitment to federal aid for highways and, second, the Highway Trust Fund may now be used for construction of preferential bus lanes, bus passenger loading areas, and fringe and transportation corridor parking facilities.

In addition to this legislation, several other bills seeking to use the monies in the Highway Trust Fund for broader purposes were introduced into the Ninety-first Congress. Although none was enacted, they serve to indicate the displeasure with which many members of Congress regard the limited goals of the Highway Trust Fund.[1] At the state

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[1] Some of the major proposals to tap the Highway Trust Fund during the 91st Congress include:

> Long sought legislation would authorize use of Trust Fund revenues to aid urban mass transportation systems, both bus and rail. For example, some pending bills would authorize the appropriation of Fund monies to the Secretary of Housing and Urban Development, who could in turn use them to make grants to states for mass transit. The governors of the states would choose how much of their federal-air highway apportionments would go to HUD for such purposes.
>
> More restrictive legislation would permit Fund monies to be used for the operation -- but not construction -- of public transportation systems. For example, Senator Randolph has introduced S. 3293, which stipulates that whenever the Secretary of Transportation "determines that the highway needs of any urban area of more than 50,000 population can be significantly reduced by applying federal-aid highway funds . . . to the operation of public transportation facilities (including rail mass transit), he may, on the affirmative recommendation of the governor of the state involved, approve the use of such highway funds" for this purpose. The governor, in turn, can act only after a local government recommendation.

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level, Maryland, Virginia and Illinois have authorized the use of some state highway user taxes to support mass transit, and similar moves are being considered by five other states.[1]

Planning. In addition to augmented funding, however, new planning mechanisms will have to be created if mass transportation systems are to have major impact on reducing private automobile use. Steps must be taken, for example, to ensure all modes of transportation are considered in a systems context before large commitments to new projects are made. As Carlos Villareal, Administrator of the Urban Mass Transportation recently stated:

> The important concept now in transportation is intermodal . . . bringing all of the means of transportation together into an interrelated, complementary system. . . . It is not enough for us to build expressways, airports, highways, port facilities, fringe parking and commuter rail lines, one without regard to the other.[2]

The development of intermodal plans suggests the need for a general transportation trust fund which could be used to allocate funds

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H.R. 14759, introduced by Congressman Leonard Farbstein of New York, would permit a governor to use his state's federal-aid highway funds to make grants for improving mass transit bus service -- including "the acquisition of buses and other operating equipment, the reimbursement of operating expenses, and the financing of terminal and other facilities provided for the comfort and convenience of the bus-riding public." Conservation Foundation Letter, June 1970, pp. 4-5.

[1] The new Maryland law created a Transportation Trust Fund and allocated to it most of the highway user revenues previously earmarked for highway uses only.

[2] Conservation Foundation Letter, June 1970, p. 8.

among all modes of transportation. This concept has been proposed in past legislation and strongly opposed by pro-highway forces. Yet there can be little doubt that the creation of a general transportation fund combined with the establishment of intermodal planning mechanisms will help to improve mass transit systems and thus help to reduce the public's dependence on the private automobile.

## Urban Design

Thus far this chapter has examined vehicle use controls, financial incentives, and mass transit as approaches to reduce automobile miles driven. Such approaches essentially represent attempts to meet given trip demands by non-automotive means. Another approach to reduce automobile miles driven would be to decrease trip demand or alternatively to reduce average trip length.

This will generally require a basic reconstituting of land use patterns since the type, pattern, and magnitude of vehicular movement closely reflects the spatial interaction between people and the activities in which they engage. For example, if cities could be compacted, houses, factories, stores, and offices would be closer together and the need for transportation (trip length) would be reduced. Greater densities would also allow transportation needs to be met economically by mass transit, in contrast to low density cities (such as those in Southwest) which must rely heavily on the private automobile.

Since the auto air pollution problem is largest in major cities where huge private investments have been sunk in existing conditions, it is hardly likely that auto emissions will be substantially reduced by major changes in the urban configuration.[1] However, land use planning should play a significant role in future "planned" cities and in guiding urban growth in existing cities. With regard to the latter, the design of new urban development could possibly eliminate urban sprawl which is characterized by inefficient spatial relationships between people and activities.

To aid urban planners in evaluating the air pollution consequence of alternate land plans and urban configurations, APCO has programmed research in this area into their six-year research plan. Among other objectives, this research will seek to determine how alternative distributions of urban activities can affect air quality by allowing transportation demands to be met by different highway systems and transportation modes. The results of such analysis will be incorporated in guideline documents for planners.[2]

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[1] This does not mean, however, that established cities are incapable of moderately altering spatial relationships to reduce trip demand. For example, two alternatives are available to reduce the common separation of inner city residents from suburban located jobs that such individuals might fill; it may be practicable either to locate low-income housing closer to employment centers or to train ghetto residents for center city employment.

[2] One major research project in this area is scheduled for completion next month. See the forthcoming report: "A Five-Year Program to Incorporate Air Pollution Considerations in Urban and Transportation Planning," Alan M. Voorhees & Associates, and Ryckman, Edgerley, Tomlinson & Associates.

# CHAPTER 4

## LOCATION

The trend toward living in urban areas is growing rapidly; by 1980 over 59 percent of the population will be living in major metropolitan areas while 75 percent will be living in all urban areas. In the year 2000, these statistics are expected to jump to nearly 66 percent and 85 percent, respectively.[1] This trend in urbanization is not limited to people -- the car population in cities is increasing even more rapidly than the human population.[2] Thus, since major metropolitan urban areas represent only about 1.5 percent of the total area of the country, the prospect is that more and more vehicular contaminants will be concentrated in a very small proportion of the atmosphere.

The strategy to combat the increased concentration of auto air pollution in urban areas consists of two basic tactics: (1) reduce pollutant emissions in urban areas; (2) modify the urban environment so as to increase assimilative capacity and the separation of people from high pollution concentrations.

All measures which can control the number of miles driven in urban areas will reduce the emissions in these critical locations. In this regard, Chapter 3 discussed the advantages of improving mass transit and encouraging car pools, as well as discouraging automobile use via vehicle use controls and price incentives. Chapter 5 will explore the possibility of putting an actual price on urban driving as a means of securing better air quality. By reducing the number of vehicles in urban areas, these measures will also increase the average speed of the remaining vehicles on the road. As discussed below, this increase in speed will result in a further decrease in emissions.[1]

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[1] Source: Jerome P. Pickard, "Metropolization of the United States", Urban Land Institute, Washington, D.C., 1959. U.S. Department of Commerce, Bureau of the Census data. Cited in The Automobile and Air Pollution: A Program for Progress (Washington, D.C.: U.S. Department of Commerce; October 1967), p. 33.

[2] See A. M. Voorhees Tables in Air Quality Standards, Arthur Atkisson Richard S. Gaines, Ed. (Columbus, Ohio: Charles E. Merril, 1970).

This chapter shall consider other, more direct, means of increasing average vehicle speed (such as by the use of traffic flow control technology) and the implications of banning traffic to a greater or lesser degree in specific urban locations.

Pollution becomes a serious problem in direct relation to the capacity of the air to disperse pollutants. So in addition to a reduction in the aggregate level of pollution in urban areas, measures designed to reduce localized concentrations of pollutants will mitigate the damages that otherwise would result from a given amount of emissions. An obvious measure along these lines would be to reduce vehicle congestion. As indicated above, this would reduce vehicle emissions by increasing average speed, but would also result in a "wider" distribution of the pollutants that are emitted. This chapter will discuss other steps that can be taken to influence the dispersion of pollutants and to reduce the exposure of people to air pollution. These include

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1. The increase in average speed is premised on urban officials taking suitable action to prevent potential users from switching to automobile use because of the lessened congestion. Congestion, as indicated earlier, is often thought to be the greatest single factor discouraging automobile use in downtown areas. The absence of congestion, such as occurs initially after new highway construction, has in the past invariably attracted new users until average speed drops to some equilibrium point. Measures to discourage new automobile use, such as taxes on parking fees, were discussed in Chapter 3.

alternate land use plans and urban configurations, the design and location of highways, and the alteration of traffic patterns.

## Emission Reduction

### Increasing Average Vehicle Speed

As table 4-1 indicates, the largest amount of contaminants from the automobile is emitted during the phases of acceleration and deceleration. Such phases increase with the stop-and-go conditions in congested urban locations.

Table 4-1

PERCENTAGE OF CONTAMINANT EMITTED PER MILE, IN EACH MODE OF I.C.E. OPERATION[1]

| | Gross Hydrocarbons | Carbon Monoxide | Oxide of Nitrogen |
|---|---|---|---|
| Idle | 5.9% | 7.5% | 0.03% |
| Cruise | 14.1% | 14.3% | 21.40% |
| Acceleration | 56.2% | 62.2% | 78.50% |
| Deceleration | 23.7% | 16.1% | 0.17% |

These data suggest that one way to reduce automobile emissions is to increase uninterrupted vehicular flows. Average vehicle speed has

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1. Source: A. M. Voorhees, "Variables Affecting Traffic and Vehicular Operating Conditions in Urban Areas" in Air Quality Standards, Arthur Atkisson, Richard S. Gaines, Ed. (Columbus, Ohio: Charles E. Merril, 1970).

been found to be a good index of the extent of acceleration, deceleration and idle driving on a given route. Consequently, measures which increase average vehicle speed can reduce the total amount of pollutants per mile traveled.[1] The potential of such measures should not be underestimated; although vehicular traffic is almost evenly divided between urban and rural areas, the slower traffic in urban areas accounts for 70 percent of total vehicle emissions for carbon monoxide (with hydrocarbons and oxides of nitrogen somewhat lower).

Expressways. If properly designed (see below), high speed expressways can reduce the total amount of pollutants emitted from vehicles per mile traveled. They allow vehicles to run without interruption and at efficient cruise speeds -- ideally about 55 miles per hour for most vehicles.[2] Also, because superhighways let motorists reach their destinations faster, drivers and occupants in these vehicles are exposed to the remaining concentrations of pollution for far shorter periods of time.

The application of flow control technology on expressways could, in many cases, significantly increase average vehicle speed.

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1. This reduction in pollution, however, does not apply across the board. Hydrocarbon and carbon monoxide emissions decrease, while nitrogen oxides and lead emissions increase in concentration with higher, hotter engine speeds. An analysis of emissions at different speeds can be found in John T. Middleton and Wayne Ott, "Air Pollution and Transportation", Traffic Quarterly, April 1968, pp. 175-189.

2. Maryland State Roads Commission, Bureau of Highway Information, cited in Prince George's County News, April 9, 1970.

For example, "metering" of traffic through control of volume of traffic allowed to enter at selected access ramps at peak travel periods can substantially increase peak hour travel speeds by preventing overloads, while maintaining the same volume of traffic using the freeways during peak hours. The increased average vehicle speed will reduce auto emissions as well as provide the basis for a high speed bus service if buses are given priority at access ramps. Experiments are now under way in a number of large cities to give buses such preferential access and thereby achieve an express transit operation at a minimum road cost.[1]

Programming for higher speeds, rather than higher volumes (as is generally the motivation for installing such expensive systems) may severely diminish the capability of the area road network to satisfy transportation needs. Yet, even if metered freeways could initially increase average speed without critically undermining capacity, this accomplishment may be only temporary. If the total demand is allowed to expand freely, as in the past, metered freeways would attract more vehicles to them than the system would allow on the freeways in a given period of time. Consequently, long queues would form on the approach ramps. Unless a decision were taken to limit the aggregate demand by pricing, it would be difficult to prevent this situation from occurring. Such a decision, however, would usually be politically

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1. For a discussion of highway flow controls and mass transit, see Sumner Myers, "Technology and Urban Transit" in Business Horizons (Summer 1967), pp. 68-69. See also "Busway-Freeway Rapid Transit", Automobile Manufacturers Association (December 1969).

unfeasible. Thus, the major benefit of a flow control system might well be the opportunity it provides for a rapid bus transit system since buses, given priority, would not be affected by ramp congestion. It is for this reason that the recently enacted Federal Highway Act of 1970 permits the Highway Trust Fund to be used to support the implementation of highway flow control systems. One consequence may be a rapid increase in the number of metered highways.

Streets. Street systems in major urban areas (especially older cities) generally were not designed to handle the volume of traffic they are now called upon to bear. Consequently, driving on city streets is often characterized by low vehicle speed and frequent stop and go operations. Average vehicle speed and uninterrupted travel can be increased on city streets by efficient design of the traffic control network. Many cities, for example, are experimenting with computer simulation of traffic flows to achieve optimal sequencing of traffic signals. As an added measure, "metering" vehicles into downtown areas at peak hours could prevent serious congestion.

However, modifications to the existing traffic control network are probably a more practical scheme in most cities. It is now technically feasible to build "closed loop" traffic systems, that is, systems responsive to changes in traffic conditions. Furthermore, such systems could be designed to sense the approach of a bus in the traffic stream and thus could be made responsive to moving people and not simply vehicles. Giving buses priority on time-shared city streets, as discussed in Chapter 3, is a crucial factor in stimulating bus ridership.

As a long-term operation, stop and go traffic can be minimized by separating rights of way at intersections. Separate pedestrian routes can often be created by building either elevated or underground passageways and traversing the upper stories of buildings. Similarly, overpasses, underpasses and multi-level networks are very helpful in separating traffic flows in different directions, but they are extremely costly.[1]

Staggering. Congestion might also be decreased by staggering work hours to reduce the peak hour loading of vehicles that is so often a major cause of traffic delays in urban areas. One elaborate study showed rush hour crowding could be reduced by 25 percent in Manhattan just by staggering working hours in the largest offices and factories.[2] But since the direct imposition of any such scheme would represent a large intrusion of government into the private sector, it is often politically difficult to implement effective staggering.[3] However, it should be noted that a degree of staggering already exists in many urban areas where substantial numbers of workers arrange to travel earlier or later than the standard hours in order to avoid the rush hour peaks. Another point

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1. For a discussion of the urban and cost considerations in reducing the number of intersections per mile of street network, see Ibrahim M. Jammal, "Vehicular Air Pollution: Variables Influencing the Urban Transportation System" in Air Quality Standards, Arthur Atkisson and Richard S. Gaines, Ed. (Columbus, Ohio: Charles E. Merril, 1970), p. 159.

2. Finding of six-year study directed by Lawrence B. Cohen of the Department of Industrial Engineering of Columbia University, 1965. Cited in Edward Banfield, The Unheavenly City (Boston: Little, Brown and Company, 1968) p. 8.

3. For an indication of the political difficulties associated with staggering work hours, see Ibid., p. 9.

to be borne in mind is the changing nature of business being carried on in downtown areas. The high cost of space is tending to restrict the business population to those firms requiring constant public contact. It follows that the employees of such firms are obliged to work "normal" hours and thus staggering would provide an unacceptable solution.

## Traffic Bans

Restricting the use of automobiles in certain major urban areas may be necessary to avoid high concentrations of pollution. One source estimates that as much as 75 percent of the traffic may have to be restricted in certain large metropolitan areas if health standards are to be achieved.[1]

The most stringent measure in this regard would be an our-right ban of the automobile from inner city areas. Although this is strongly advocated by environmentalists, such proposals have received little serious consideration. The California legislature, however, did discuss -- and reject -- one bill during the past session that would have banned cars from the core areas of 19 major California cities.

Such legislation can only be a possibility where the local mass transit systems are capable of handling the commuter population. But even if mass transit is available, such as in New York where 80 percent of the people who come to work in the central business district use public transport, banning cars from large cities may radically alter the whole complexion of the urban areas:

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[1] National Air Quality Standards Act of 1970, Report of the Committee on Public Works, United States Senate, Report No. 91-1196 (September 17, 1970), p. 2.

> The solution to the auto-transit problem involves the delicate balance between technology and humanity that creates a living city. If New York goes too far in preventing use of automobiles and banning them from the city, it is feared the city will die as those who live there move out -- except for the rich and the poor (a trend already well established). In effect, . . . the city would be re-establishing medieval walls, erasing the mobility of modern urban civilization while creating bastions for commerce only. One thinks of the empty caverns of Wall Street on Sunday afternoon to illustrate the potential future of a city without people.[1]

A less stringent measure than the total ban is the selective ban -- the diversion of traffic flow away from major business and shopping areas. Tokyo is now banning all cars from 122 of its busiest streets on Sundays, the busiest shopping day in Japan. The elimination of automobiles in one normally congested area caused the downtown pollution level to fall to half its normal reading.[2] Following this example, one-mile stretches of three major New York throughfares were declared off limits for automobiles on weekends and week nights during parts of the summer, fall, and Christmas shopping season. The carbon monoxide level on some auto-less streets was reported to have fallen by as much as 90 percent.[3]

In addition to reducing auto air pollution, the Tokyo and New York experiences bear out two important lessons. First, and contrary to merchants' expectations, sales did not suffer.[1] Secondly, through careful planning, traffic can be re-routed successfully in two of the world's most crowded cities. Conceivably, urban transportation planners could relate the magnitude of automotive emissions to the required air quality criteria and determine the optimal re-routing plan in terms of the degree of control required. This will allow traffic restrictions to be only as extensive as air quality needs require, and thus the disruption of "normal" activities will be minimized.

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[1] The Washington Post (August 23, 1970), p. D-1

[2] "Clean Air and Automobility", The Washington Post (August 5, 1970), p. A-18.

[3] "The Ban-the-Car Movement", Newsweek (January 4, 1971), p. 42.

One expert on urban planning offers guidance on the development of programs for restricting traffic:

> For each city, the immediate planning question is what reduction in automobile traffic is feasible, given the presently available alternative modes of transportation. Such a reduction might be phase I of a long-run program. The answer will depend on the particular city. It will be necessary to examine a broad spectrum of proposed restrictions, including variations in area coverages; times of the day; types of vehicles; trip purposes; number of passengers per vehicle; etc. Such a study would determine what is immediately feasible, or -- through application of criteria -- which of the things which are feasible are most economical or efficient.
>
> It is entirely possible that the most feasible program would not be a complete ban on automobiles. Another possibility is that the feasible reduction in automobiles which could be implemented would not be sufficient to meet air quality criteria entirely but only to move in that direction. If this were so, further steps would need to be taken. If the immediately feasible were implemented as phase I, phase II might incorporate an expansion of public

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[1] Sales in Tokyo actually ran 50 percent above the usual figure. Other areas where shopping streets have been established have found the arrangement draws large crowds. "Clean Air and Automobility", The Washington Post Post (August 5, 1970), p. A-18. However, the inability to carry certain types of merchandise long distances could alter thennature of retail business activity in auto-less business districts.

> transportation facilities, some advance in the technology of public transportation, or improvement in the control of vehicular emissions.[1]

## Dispersion

### Urban and Transportation Planning

Where pollutants can be rapidly dispersed, higher emissions can be tolerated and, conversely, where local air is stagnant so that pollutants collect, only very low emissions can be tolerated. Urban planners with a basic understanding of micrometeorology, the process involved in small scale atmospheric convection and diffusion, can adopt measures to influence the dispersion of air pollutants. Of particular importance, this knowledge will permit planners to take effective action to separate people and the source of emissions through alternate land plans and urban configurations. Unfortunately, however, the state of the art in environmental planning is in its infancy; methods have not yet been devised for determining the potential air quality associated with a particular plan or design. Although there have been many attempts, for example, to develop accurate mathematical models of the dispersion of pollutants from sources such as freeways, these models frequently underestimate the concentrations at given distances from the pollution source being measured. This is primarily due to the difficulty in accounting for other nearby sources of pollution and the wide variations in urban landscape.[1]

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[1] Guy Black, The Downtown Ban on Automobiles (Washington, D. C. George Washington University, mimeo, August 7, 1970), p. 6. The author also points out the importance of technological forecasting in developing traffic restriction programs and the need for studying the effects of such programs on areas surrounding the downtown core.

Recognizing the need for fundamental research, APCO has programmed extensive studies of environmental planning into their six-year research and development plan.[2] This plan highlights the two major areas for abatement of air pollution by influencing dispersion: long term urban design and highway design and location.

## Long Term Urban Design

The spatial distribution of urban activities affects the distribution of vehicular emissions and the resultant ambient air concentrations. Methodologies are needed to evaluate selected land plans, to estimate the pollution potential of alternate land designs, and to relate air pollution concentrations to the size and location of parks, open spaces and green belts.[3]

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[1] One source notes that diffusion models usually predict carbon monoxide concentrations one-half to one tenth of those actually measured. See "Air Quality Criteria for Carbon Monoxide", (National Air Pollution Control Administration Publication No. AP-62 U.S. Department of Health, Education, and Welfare; March 1970), pp. 6-26, 6-27. See also "Workbook of Atmospheric Dispersion Estimates" (Public Health Service Publication No. 999-AP-26, 1967).

[2] See discussion on p. 3-23 for details of this plan as it relates to reducing emissions by altering the spatial arrangements of people and activities. Discussion here will be devoted to aspects of the plan relating to pollution concentration.

[3] For an analysis of land use planning as it relates to mobile source air pollution control, see Salvatore J. Bellomo, "Ways to Reduce Air Pollution through Planning Design and Operations," prepared for presentation at the 50th Annual Meeting, Highway Research Board (Washington, D.C.: January 1971). However, in contrast to the body of research done to relate the location of stationary sources of pollution to meteorological conditions, very little is known about locating major traffic flows to air current patterns. See Ibrahim M. Jammal, "Vehicular Air Pollution: Variables Influencing the Urban Transportation System" in Air Quality Standards, Arthur Atkisson and Richard S. Gaines, Ed. (Columbus, Ohio: Charles E. Merril, 1970).

On a smaller scale, investigation is needed into the potential of various building patterns to abate pollution concentration. High and low rise buildings when alternated, for example, can create favorable air turbulence. Similarly, laying streets along breeze lines can cause contaminants to disperse more rapidly.

Highway Design and Location.

Certain highway designs and locations may lead to greater concentrations of pollution either on the highway or the areas immediately adjacent to it. An analysis of the proposed Lower Manhattan Expressway undertaken by the New York City Department of Air Resources revealed such construction would result in dangerously high carbon monoxide levels. Among other reasons, the proposal was rejected on the basis of this study.[1] Another New York study documents the potential air pollution damages of poor highway location to the surrounding area. This analysis revealed that the carbon monoxide levels measured at the top floors of buildings located above an interstate highway were as high as the hazardous rush hour levels in downtown Manhattan street level.[2]

The Federal Highway Administration has issued guidelines which require state highway departments to consider the impact on the environment of proposed new highway construction. Among other factors, these guidelines specify air pollution as an environmental effect to be weighed. However, nowhere are minimum standards prescribed for the information needed to support required considerations of environmental effects. Consequently, air pollution (as well as other environmental considerations such as noise pollution) is usually given short shrift in planning new highways.[1]

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[1] "An Estimate of Vehicular Air Pollution Potential of the Proposed Lower Manhattan Expressway in New York City," New York City, Department of Air Resources, November 1965.

[2] Cited in "Statement of the Metropolitan Washington Coalition for Clean Air," July 15, 1970, p. 4. To preclude the possibility of such health hazards occurring, this organization has formally demanded the suspension of the proposed District freeway system pending a comprehensive study of potential air pollution effects.

Methodologies are needed to translate traffic estimates into expected pollution concentrations at various distances from the road. Also needed are guideline documents to provide transportation planning agencies with criteria relating air quality to various highway design configurations. Presumably such guidelines would give concentrations as a function of traffic mixes and flows and as a function of lane width.[2]

Proper highway design would include provision for the maximum possible distance between vehicle routes and adjacent dwelling places, maximum distance between traffic lanes and sidewalks, and maximum width of traffic lanes and median strips. It is especially helpful to have landscaping alongside of highways with the landscape belt as wide as possible. Such provisions allow for the greatest dilution of emissions

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1. To remedy this situation, a three-day environmental workshop was held (July 7-9, 1971) in Washington, D.C., by the Highway Research Board of the National Academy of Sciences. One sub-panel devoted its efforts to modifying a draft set of air pollution guidelines. The final product is expected to be published shortly.

2. General Electric Company, "Final Report on Study of Air Pollution Aspects of Various Roadway Configurations," submitted to the New York City Department of Air Resources, June 6, 1971.

before they can reach smog-causing concentrations and before they infiltrate residential and pedestrian areas.[1]

Alteration of Traffic Patterns

As indicated above in the discussion of traffic bans, certain selective bans may have the primary effect of rerouting traffic rather than discouraging automobile use. Altering traffic patterns could be an important tool in redistributing emissions in a more regionally favorable manner.

A recent experiment undertaken in Gothenburg, Sweden, indicates the potential of innovative transportation planning to re-route traffic so as to avoid high center city pollution concentrations. By constructing actual barriers, urban planners divided the city into five sections; through traffic from one section to another (with the exception of emergency vehicles) was made impossible. Intracity driving required exiting from a particular section, driving on a "ring" road, and then entering the desired section. Initial information indicates this approach is highly successful in lowering air pollution concentrations in the center city area.[2]

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1. For a comprehensive discussion of highway design for air pollution control see John T. Middleton and Wayne Ott, "Air Pollution and Transportation," Traffic Quarterly, April 1969. See also M. G. Schneiderman, C. K. Cohn, and G. Paulson, "Air Pollution and Urban Freeways: Making a Record on Hazards to Health and Property," The Catholic University Law Review, Fall 1970.

2. Organisation for Economic Co-operation and Development, "The Gothenburg Traffic Restraint Scheme." (Paris: April, 1971.) Mimeographed.

# CHAPTER 5

## EMISSIONS CHARGE SYSTEMS[1]

From an economist's point of view, an ideal method of ensuring socially desirable automobile ownership and usage patterns would be to measure the precise emissions from a given vehicle in a given location and impose a charge related to the social cost of that amount of pollution in that location.[2] This would make the previously hidden cost of pollution a real dollar cost to motorists. Supply and demand forces would then function in a market context to allocate vehicle ownership and usage patterns in a socially tolerable manner. Such an emissions system would give each motorist both the information (dollar costs of his pollution) and the incentives (desire to minimize costs) to reduce his contribution to the auto pollution problem.[1] This motorists can do, as indicated throughout, in three basic wasy: 1) shift to a lower emissions class; 2) reduce automobile usage, and 3) avoid driving in highly polluted areas.

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[1] For a comprehensive discussion of emission charges in air pollution control, see Governmental Approaches to Air Pollution Control: A Compendium and Annotated Bibliography, prepared by the Institute of Public Administration for the National Air Pollution Control Administration, 1970, Chapter 8. Except for different considerations related to monitoring and administering an emission charge system for automobiles, that discussion applies in total. Hence, the discussion here will highlight only those aspects that are of particular relevance to the automobile problem.

[2] The concept of securing rational allocation of a scarce resource by assessing a charge related to the cost to society of specific automobile use is not new. Much research has dealt with the possibility of congestion pricing, that is, charging motorists a price reflecting the increase in congestion resulting from their decision to drive in specific locations. Although the damage in these studies is increased travel time, there is no reason why environmental costs could not be included. Studies on congestion pricing thus yield considerable insight into developing emission charge schemes. See Road Pricing: The Economic and Technical Possibilities /the "Smeed Committee" Report/ (London, England: HMSO, June 1964). More recently, see Gabriel J. Roth, "Traffic Congestion as a Source of Revenue," Traffic Quarterly (April 1970), p. 175.

Measures to control the level of the first two variables via a price mechanism were discussed in Chapter 2 and Chapter 3, respectively.[2] Chapter 2 included discussion of discriminatory taxes as a means of shifting motorists' preference to lower emission classes and Chapter 3 included discussion of a direct usage tax (via a tax on gasoline) as a means of reducing miles driven. It was mentioned in each of these chapters that the significant disparity in ownership and usage habits among motorists will most likely result in large inefficiencies and inequities if policy makers impose tax systems based upon only one of the three variables. Charges based upon the emissions class of a vehicle, for example, could result in large expenditures for control equipment by those who use their automobiles infrequently or primarily in rural areas. Alternatively (assuming a simple fuel tax is imposed), those motorists with virtually pollution-free cars will be assessed approximately the same charge for driving a hundred miles as those driving "smoke belchers."[1] In addition to these considerations, charge systems based upon a single variable cannot guarantee a reduction in pollution damage since changes in the levels of the other two variables may overwhelm the effects of any reduction in the variable being controlled.

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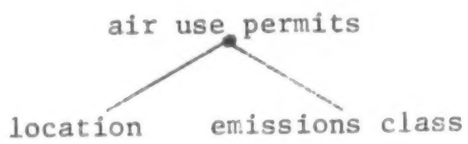
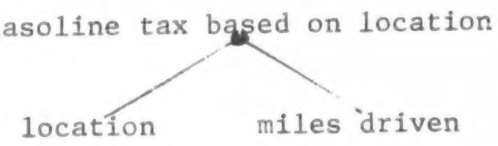
[1] An emission charge system aimed at automobile manufacturers was discussed in Chapter 1 (see pp. 1-20 to 1-24). This chapter will be devoted to discussion of emission charge systems directed at individual motorists.

[2] A price could be applied to the third variable (location) in the form of a congestion charge. Since the concept involved in congestion pricing is identical to that being developed here, it was omitted from discussion in Chapter 4.

Theoretically, an ideal emission charge system would provide control over all three variables simultaneously. Specifically, it would apply a charge based upon the number of miles a vehicle in a specific emissions class is driven in a particular location.[2] As will be discussed below, the technical feasibility of such a "complete" emissions charge scheme will depend upon the development of sophisticated monitoring technology. In the absence of such technology, or if a "complete" scheme were too costly or too instrusive to administer, two "incomplete" emissions charge systems could be considered. These measures apply a charge related to the levels of two variables :





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[1] Any difference in charge will be related to a difference in fuel consumption. Since higher emitting cars generally consume more fuel, a simple fuel tax will discriminate, to some degree, on the emissions characteristics of the automobile.

[2] Theoretically, the term "emission charge system" should be applied only to those measures which simultaneously control all three components of pollution damage. However, measures which impose charges related to emissions class or miles driven can also be considered to place a price on emissions insofar as those variables are correlated with the magnitude of emissions. For the purposes of differentiating among possible emission-related charge systems, measures which apply a charge based on consideration of all three components of pollution damage will be called a "complete" emission charge system, while measures which apply a charge related to the levels of one or two of the components will be called "incomplete".

These approaches will be considered and then followed by an attempt to combine them into a "complete" emissions charge system. Following that, the chapter will consider the implications of sophisticated monitoring technology for the development of a "complete" system.

## Relating Emission Classes to Location

### Air Use Permits[1]

Given the emission class of a particular vehicle (see Chapter 2) and with the assumption that the vehicle is used an average amount, the environmental cost of automobile use will depend largely on the location in which the automobile is operated. To relate usage of a certain type of vehicle to location of use, the country could be divided into zones on the basis of the social costs of emitting an additional quantity of pollution in that vicinity.[2] The zones could be numbered say, from "0" (low population areas with high ventilation) to "3" (inner-city areas or other areas where pollution levels are chronically high). A charge would be assessed in the form of required purchase of an air use permit. The cost of the permit would be related to the emissions class of the car and the highest pollution zone in which the automobile is to be operated. For example, the price of a yearly zone "3" permit for an automobile in emissions class "4" would equal the expected social cost of the emitted air contaminants using the assumption that the automobile will be used an average amount.[1]

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[1] This section as well as many of the insights in this chapter are attributable to Anthony B. Low-Beer, "The Use of Effluent Charges to Control Air Pollution and Induce an Efficient Allocation of Resources", Columbia University, 1970 (unpublished Ph.D. thesis).

[2] The social cost of an incremental amount of pollution is generally regarded as directly related to the existing amount of pollution in the location of vehicle use. This assumption is employed here. However, it should be emphasized that many individuals may feel additional pollution in a relatively pollution-free area is, indeed a costly degradation of the environment equal in social cost (if not greater) to emissions of similar magnitude in a high pollution area.

Physically the air use permits could take the form of a windshield sticker conveying the following information (perhaps by geometrical shape, color, size): (1) emissions class of vehicle; (2) highest zone for which use is permitted, and; (3) date of expiration.

The operation of an air use permit scheme would appear to be well within the range of administrative feasibility. Permits could be sold in gasoline stations and in parkway toll booths. Since the cost of administering such a system in "0" areas would probably outweigh the benefits to be obtained, permits would probably not be required in these zones. Conceptually, enforcement, which includes traffic surveillance and punishment of violators, does not seem to present any major difficulties either -- traveling without an air use license or with a permit for a lower emissions class vehicle, or operating zone would

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1. Air use permits need not only be sold on an annual basis; permits could be sold for time periods as short as one day or even less. Such flexibility would allow tourists or transients to purchase permits for only their period of automobile use in a zone for which they do not have a permit. As permit costs are based on expected usage, charges for short duration would be proportionately greater than for annual permits -- a permit issued for a single day could be expected to be used on that day, while yearly permits assume only "average" use. The enforcement of short duration permits might be difficult, but the issuance of "self-cancelling" stickers could resolve this problem. After activation (rubbing or peeling off top surface), these stickers would change color upon expiration.

constitute a violation. Similarly, the sale of a permit of lower than rated emission category (which would be found on the vehicle's registration) could subject the seller to a fine.

Some difficulty may arise if all vehicles do not have emission ratings, as might be the case for vehicles predominantly used in zones not requiring a permit. A mechanism for testing or estimating the vehicle's emission class would have to be established prior to a permit being issued.[1]

Interzone transfers would not constitute a problem unless some individuals found that many of their trips required only minimal entrance into a high pollution zone, and thus felt purchase of the high zone permit was an unjustifiable expense. These individuals, as well as others, might decide to risk penalty rather than make a costly purchase while travelling only a short distance in a high pollution zone. However, the majority of such motorists would probably find it most advantageous to purchase a zone "3" (maximum zone permit) on an annual basis.

The expected benefit of such a system then, would not be in altering the location of predominant automotive use, but primarily in influencing the motorist's choice of vehicle and maintenance habits. A low emissions class rating under an air use permit system would mean sharply reduced operating costs, especially in highly polluted areas. One study estimated that an air use permit scheme in New York City

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The feasibility of air use permits is dependent upon the establishment of state emission checking programs in areas where permits would be used. Emissions need not be actually checked, however, if accurate estimation procedures are available (see p. 2-13).

related to pollution damage would cost a relatively pollution-free automobile \$80-\$90 annually, while a relatively uncontrolled emitter might face fees up to \$800-\$900, or more.[1]

The air use permit system would not preclude the ownership of high emission cars (as very strict standards might) for those who use cars primarily for low zone driving or for those who value the performance of such cars above the considerable annual cost of the required permits.

## Relating Miles Driven to Location

### Fuel Tax Based on Location

The air use permit system represents the marginal social air pollution costs of automobile ownership, given that the vehicle is used in average fashion. Such a system, however, cannot represent the cost of driving an additional mile once the permit has been purchased. In the absence of monitoring equipment which could precisely determine vehicle usage, a tax on gasoline consumption could be imposed as a charge representative of the air pollution cost of vehicle usage in a particular location. For example, the additional tax on gasoline in a relatively pollution-free area might be \$0.05 per gallon whereas it might be \$0.20 per gallon in an area with considerably greater pollution. Such a fuel tax would represent the marginal social cost of burning a gallon of gasoline in the area where the gas is purchased by an "average" automobile.

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[1] Anthony B. Low-Beer, "The Use of Effluent Charges to Control Air Pollution and Induce an Efficient Allocation of Resources", Columbia University, 1970 (unpublished Ph.D. thesis). This estimate assumes auto-related damages in New York City amount to \$800 million annually, and that the highest emissions class emits approximately ten times as much pollution as the lowest class.

The implementation of a fuel tax based on location will require careful administration and enforcement. Since the tax on a gallon of gasoline will be very high in highly polluted areas,[1] some motorists would be motivated to drive to low pollution areas to purchase gasoline. Such behavior would not only result in massive evasions of the emissions charge, but would also result in socially wasteful driving by causing additional congestion and pollution. This sort of behavior could be curtailed by basing fuel tax sales on an average, or perhaps a weighted average social cost of burning fuel within a one-half gas tank radius (approximately 125-150 miles). This would reduce the charge differential between high and low pollution zones and make it less profitable to travel a great distance to buy lower priced fuel. Of course, suitable restrictions would have to be imposed, similar to the restrictions on interstate transportation of liquor, to prevent unscrupulous individuals from "bootlegging" gasoline purchased in low pollution zones.

A fuel tax based on location would provide the incentive for motorists to reduce automobile use in those areas where pollution levels are chronically high. As discussed in Chapter 4, this will also result in a beneficial increase in average vehicle speed in urban areas. However, by itself it will provide no incentive for motorists to shift to lower emission classes through purchase of new vehicles, purchase of additional control equipment, or through better vehicle maintenance.

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[1] One source estimates the tax in New York City representative of the social cost of burning a gallon of gasoline there would be approximately $0.80 per gallon. Anthony B. Low-Beer, "The Use of Effluent Charges to Control Air Pollution and Induce an Efficient Allocation of Resources", Columbia University, 1970, Chapter 5, (unpublished Ph.D. thesis).

## "Complete" Emission Charge System

### Without Sophisticated Monitoring Equipment

Since the gasoline tax fails to represent variations in emission-per-mile ratings (emission classes), and the use of air permits does not account for the marginal pollution cost per mile of use, an ideal system would involve a combined air use permit/fuel tax scheme. These two systems could be combined by issuing an automobile owner a ration card stating the vehicle's emissions class which would entitle him to purchase fuel according to specified fuel tax schedules related to the emissions class of the vehicle and the location of gasoline purchase. Alternatively, one economist suggests motorists could get a gasoline tax rebate on the basis the emissions class of their automobile and a record of the location and amount of gasoline purchases substantiated by means of tear-off vouchers, "trading stamps", or a log book of some kind.[1]

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[1] William Vickrey, "Theoretical and Practical Possibilities and Limitations of a Market Mechanism Approach to Air Pollution Control", Air Pollution Control Association Meetings, Cleveland, June 11, 1967, p. 8.

Although the former approach is preferable to the latter since it would avoid the necessity of establishing a complicated mechanism for refunding gasoline taxes, two substantial defects must be noted.

First, it would be extremely difficult, if not impossible, to ensure that gasoline purchasers paid the full tax. A compliance program would have to be established, probably consisting of government inspectors making random fuel purchases.

Second, the charge rate might vary from $2.00 per gallon for poorly controlled cars in high pollution areas to $0.20 per gallon for low emission vehicles in rural areas. Obviously, there would be a temptation to purchase gasoline from rural stations in special low emission vehicles with large gas tanks and then siphon it off for use in higher emitting vehicles or for sale on the "black market". In view of these considerations, it is highly unlikely that a combined fuel-tax/air-permit system of this sort could be made evasion-free at reasonble cost.

To overcome some of the difficulties in combining the two systems, another economist suggests that it might be desirable to separate the two systems and to assume that each will account for one-half of automobile operating costs. However, unless an "average" automobile is used an "average" amount, this approach will not result in the proper environmental cost being assessed to a particular automobile. This defect, in conjunction with others, requires that the modified approach be rejected as well.[1]

## With Sophisticated Monitoring Equipment

The difficulties with the "complete" emission charge systems discussed above are attributable to the fact that actual vehicle emissions are not measured directly but are inferred from surrogates; emission class represents pollution potential, gasoline consumption represents miles driven, and an air use permit represents location. If actual automobile emissions in a given location could be monitored directly, all of the difficulties cited above could be overcome.[2]

One method for monitoring vehicle use was described in the Smeed Report and is now being studied by the British Road Research Laboratories.[3] A meter would be mounted in each vehicle that would be actuated by electric pulses emitted from induction loops imbedded in the roadway. As a means of discriminating between locations, the density of the loops could be proportioned to the average pollution level in the area. Periodically the meter would be read and a charge imposed corresponding to the estimated social cost of a vehicle of that emission class driving the metered number of units.

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[1] For the analysis leading to this conclusion see Anthony B. Low-Beer, "The Use of Effluent Charges to Control Air Pollution and Induce an Efficient Allocation of Resources", Columbia Univeristy, 1970, Chapter 5, (unpublished Ph.D. thesis).

[2] It will not be necessary to measure directly exhaust emissions from individual vehicles, for example, by putting a meter on the tailpipe. If miles driven in a given location by a specific automobile are known with accuracy, this statistic could be combined with emissions class for a reliable estimate of "actual" emissions.

[3] See Road Pricing: The Economic and Technical Possibilities (London: HMSO, June 1964).

The development of Automatic Vehicle Monitoring (AVM) systems offers the possibility of both more accurate monitoring of vehicle use and the automation of billing procedures. Using a simple AVM system, response blocks would be mounted on cars permitting scanners located at various points along the road to identify the cars as they pass. The records made by individual cars could be processed by a central computer and a monthly bill sent to individual motorists. A more sophisticated AVM system would permit the continuous monitoring of the location of any vehicle within an accuracy of 100 feet in a metropolitan area 50 miles in diameter. A central transmitter would broadcast repetitive signals -- each signal addressing one particular vehicle whose equipment recognizes its own coded signal among all the others. On receiving the coded signal, the addressed vehicle activates a keyed transmitter which produces a respond-acknowledge (R-A) signal. At least three roadside receivers, perhaps on towers, pick up this R-A signal and relay it to the central computer. The vehicle's location is then computed by triangulation using the differences in arrival times of the R-A signal at the three roadside receivers. As above, charge computation and billing could be done efficiently by computer.[1]

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[1] For a comprehensive discussion of AVM systems, see An Analytic and Experimental Evaluation of Alternative Methods for Automatic Vehicle Monitoring (Institute of Public Administration: July 1968).

## Summary and Conclusions

Advantages. A "complete" emission charge system would allow each motorist to adjust his automobile ownership and usage behavior in a manner consistent with his personal value preferences. The attempt by motorists, as an aggregate body, to lower transportation costs will insure a desired air quality level can be met, without resorting to direct regulation. This will result, as indicated previously, in increased efficiency of resource allocation, and more equitable assessments for pollution damage.

The establishment of an emission charge system would probably alter presently observed consumer automobile purchasing behavior in a significant way. Rather than the present emphasis on performance and styling, emissions characteristics would play an important role in the vehicle choice process. What is more, the explicit desire of motorists to own low pulluting vehicles may furnish the automakers with increased motivation to produce low emission vehicles. And as such time as unconventional vehicles become available, an emission charge system will speed the transition.[1]

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[1] "In the absence of an effluent charge of some sort, it is difficult to see how adequate incentives can be offered for the switch to electric /or other unconventional/ cars, unless indeed the latter are subsidized in some way. A subsidy, indeed, would have the double disadvantage of requiring added taxes usually of a distorting nature, for the financing of the subsidy and of increasing the distortions already existing in the large hidden subsidies from which users of private automobiles for commuting in congested areas already benefit; moreover commuters are, as

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Problems. Although the state of the art of monitoring technology is well advanced, it is uncertain at the current time whether it would be possible to implement emission charges on a large scale; neither has sufficient research been done to determine the costs of establishing and administering such a charge system, nor to determine whether the equipment can be made sufficiently foolproof to serve as a basis for revenue collection. With regard to costs, one source contends that, at least for the foreseeable future, pollution costs would be insignificant in magnitude to support such an elaborate system of collection.[1]

But even if the mechanics of monitoring and revenue collection could be resolved at reasonable cost, there would be two significant drawbacks to implementing an emissions charge system.

First, political feasibility. A substantial possibility exists that the public will resent the imposition of "taxes on driving",

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a whole, probably better off on the average than those who would probably be required to bear the burden of the tax as a practical matter. With effluent /emission/ charges in effect, adequate incentives can be provided for the change, and the change can be made gradually with the change being made first where the difficulties are least and the benefits greatest. An attempt to promote electric vehicles by fiat, as by banning all but electric vehicles and vehicles with special licenses from certain areas is likely to produce so many cases of throwing the baby out with the bathwater as to encounter serious opposition and at best the transition will be made in an arbitrary and inefficient manner." William Vickrey, "Theoretical and Practical Possibilities and Limitations of a Market Mechanism Approach to Air Pollution Control," Air Pollution Control Association Meetings, Cleveland, June 11, 1967, p. 8.

2. However, Vickrey further contends an emissions charge system might be cost efficient if made part of a system of collecting congestion charges. Ibid.

as an unwarranted intrustion of government into the private sector. In fact, the invasion of privacy issue will probably be sufficient to reject the implementation of an AVM system which would enable the government to monitor individual automobile use.

Second, communicability. Motorists must clearly understand how the system works if it is to be effective in curbing auto pollution. Although the concept is relatively simple, complexity will increase as the system becomes operational. It is not clear at present how government could secure universal understanding of the details of an emission charge system.

To sum up, the "complete" emission charge system does not appear to be a feasible alternative at present. Of the two "incomplete" systems discussed in this chapter, air use permits would be administratively easier to establish and maintain as well as result in greater air quality benefits; given a choice, individuals would probably purchase different equipment in reaction to financial penalty, rather than restrict their automobile use.

Subject to the criticisms discussed in Chapter 2 and Chapter 3, both the tax on emission class and the simple gasoline tax appear to be administratively feasible and capable of reducing auto pollutant emissions. With respect to choosing among various emission charge systems, it is worth remembering that "the real question is not which system is theoretically perfect but which is actually capable of achieving the highest degree of compliance most efficiently."[1]

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[1] J. Clarence Davies, III, The Politics of Pollution (New York: Pegasus, 1970), p. 179.

# CHAPTER 6

## TOWARD A FEDERAL STRATEGY

The underlying premise of this document is that unless virtually pollution-free automobiles can be produced on a large scale, federal policies aimed at control of the source must be supplemented by measures which control the other components of pollution damage -- miles driven and location of use. Certainly if near-complete control over the source could be achieved, the auto air pollution problem would cease to exist as soon as enough pollution-free cars were purchased to replace existing vehicles. However, three factors militate against a highly exclusive emphasis on control of the source, (1) the uncertainty surrounding how soon the automotive industries can achieve the stringent control required; (2) the fact that even if the automotive industries succeed in meeting the 1975-76 emission standards, the carbon monoxide levels in some cities will still be in excess of the 1975 ambient air quality standards; and (3) the cost to society of attaining the required degree of control will be enormous These three considerations require investigation of a "balanced" federal strategy and will be discussed, in turn, below.

### Uncertainty

Even if one assumes the automobile manufacturers and other private firms are totally committed to developing a pollution-free automobile,[1] there can be no assurance that they will succeed in this task in the near future. As indicated in Chapter 1, neither the ultimate limits of the internal combustion engine, nor the necessary technologies to achieve it are known. In comparison with the research experience associated with the internal combustion engine, the state of the art in unconventional engine development is far less advanced (though the problems may be less difficult to solve).[2]

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[1] Congressional displeasure with the progress of the automobile companies in controlling pollution, the large body of pending litigation, the threat of antitrust action to restructure the industry, along with the mounting public concern over clean air. have probably resulted in an increased commitment on the part of the automobile industry to develop a pollution-free industry. Dr. A. J. Haagen-Smit, one of the nation's foremost authorities on air pollution control, believes that this may be the case. In a recent interview, he stated that he is convinced that the auto manufacturers are working hard to perfect anti-emission systems and that "We're so far over the hump [in controlling the internal combustion] that I'm beginning to lost interest." Cited in "Pollutant Fight in Autos Hailed," The New York Times, January 12, 1971, p. 17.

A similar conclusion is suggested by a source generally critical of the auto industry:

> . . . by emphasizing that the way to clean air is through a clean internal combustion engine, they [the auto industry] may feel they have little to lose in supporting auto pollution abatement. As with auto safety, it was only after repeated attacks. . . that safety measures were taken. . . most of which are now a cost to the consumer and a profit to the industry. History may repeat itself if pollution control devices become a costly "add-on" requiring constant adjustment and replacement.

Ideas (Washington, D.C.: International Research and Technology, February 1970), p. 10

[2] Unconventional vehicles also face uncertain consumer acceptance unless they are clearly superior to conventional vehicles in the criteria used by motorists for vehicle selection.

What is more, automakers will not be seeking simply to develop effective technology -- in view of the increasing cost of vehicles due to safety and anti-pollution requirements, they will also be trying to develop low-cost systems.[1] Compounding the difficulties, it will not be enough, of course, to develop prototypes with pollution-free characteristics; if such vehicles are to have a significant impact on air quality, they must be durable and suitable for mass production. With regard to manufacture, the lead time from prototype development to mass production will be at least one year and probably many more.

These uncertainties about how much control can be achieved in how long a time[2] suggests that there is not, and cannot be, one and only one "solution" to motor vehicle air pollution. To deal effectively with uncertainties, several simultaneous supplementary and complementary approaches should be followed. This will allow several paths to be pursued in parallel, and hence preservation of as many degrees of freedom as possible until more certain information is available.

### Projected Carbon Monoxide Levels

Even if inspection of relevant data revealed without reservation that a pollution-free vehicle could be developed by mid-decade, evidence exists to indicate that the carbon monoxide level in major

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1. It is probably true, as many argue, that the technology could be developed quickly if cost were not a factor. Clearly, however, the cost of the system to the purchaser is a major factor to auto manufacturers.. See p. 1-5.

2. As recently as May 1971, during extensive hearings on the progress being made to curb auto emissions, automakers expressed serious reservation about the technological feasibility of meeting the standards in the required time. (See Appendix C.)

cities will be in excess of the ambient air quality standard which becomes effective in 1975.

According to William Ruckelshaus, Environmental Protection Agency Administrator, of the seven major metropolitan areas for which EPA has adequate data, only Cincinnati will come close to achieving the carbon monoxide standard by 1977. This news was released at a briefing at which EPA promulgated its final national ambient air standards for the six most common pollutants.[1] The Administrator said that Chicago, Denver, Los Angeles, New York, Philadelphia and Washington won't be able to get their carbon monoxide levels down to acceptable levels before the 1980's without taking additional transportation controls.

"This will mean they will have to make some rather drastic changes in their commuting habits," Mr. Ruckelshaus warned. He listed several alternatives, including outright bans on vehicles during certain peak hours, coupled with increased emphasis on mass transportation and car pools and regulations requiring more frequent motor tune-ups. These additional measures, he emphasized, would be required even if auto manufacturers meet their 1975 deadline for carbon monoxide reductions.

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1. On April 30, 1971, pursuant to Section 109 of the Clean Air Act as amended, the EPA Administrator promulgated national ambient air standards for sulfur oxides, particulate matter, carbon monoxide, photochemical oxidents, hydrocarbons and nitrogen oxides. Within nine months thereafter, each state is required by Section 110 of the Act to adopt and submit to the Administrator a plan which provides for the implementation, maintenance and enforcement of these standards within each region (or portion thereof) within the state.

The air quality implementation plans[1] for these areas, by law, must provide for transportation controls including, but not limited to the following: emission limitations necessitating installation of emission control (retrofit) devices, emission limitation necessitating conversion of motor vehicle fleets to low emission fuels or engines, measures to reduce motor vehicle traffic (e.g., the techniques discussed in Chapter 3 -- commuter taxes, parking limitations, staggered working hours), expansion or promotion of the use of mass transportation facilities, and, at such time as determined by the EPA Administrator, programs for periodic inspection and testing of motor vehicle emission control systems.[2]

## Cost

The actual dollar cost to motorists of controlling the source will be enormous. As with most phenomena of this nature, great progress can be made easily and inexpensively at the outset. Developing the technology to "squeeze out" the last few percentage points of control, however, will be technically difficult and costly. With regard to the latter, the cost of control devices to meet increasingly stringent federal emission standards is rising rapidly. For 1968 and 1969 models the amount was $18-$19 per car; for 1970, $36 per car; and for 1971 it is estimated at $49 per car.[3] In 1971 alone, motorists will pay

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1. Clean Air Act Amendments of 1970. P.L. No. 91-604, Sec. 110(2)(B).

2. Federal Register, Vol. 36, No. 67 (April 7, 1971), p. 6683.

3. Environmental Quality, First Report of the Council on Environmental Quality; transmitted to the Congress August 1970, p. 73.

approximately $100 million for auto pollution control equipment.[1] The application of more stringent standards will increase these costs sharply, especially considering that standards at mid-decade will be ten times tougher than the 1971 standards and will also require control of an additional pollutant, nitrogen oxides. One recently published EPA study estimates the initial cost to motorists of pollution control systems needed to meet the 1975-76 standards will be $240. However, in a recent government-industry meeting (see Appendix C), automotive industry estimates ranged from $80 to $600 per car to meet the 1975 standards.

In addition to the actual dollar cost of pollution control equipment, control of the source under the prevailing standards approach will result in large inefficiencies and inequities. All purchasers of new vehicles will have to buy sophisticated control equipment regardless of the intensity of their automotive use or the location in which they predominantly drive. Uniform standards will also curtail the range of automobile makes and models that can be offered for sale. Consequently, while across-the-board emission standards may be the simplest to administer, they are probably not the least cost solution.

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1. Environmental Quality, First Report of the Council on Environmental Quality; transmitted to the Congress, August 1970, p. 73.

2. "The Economics of Clean Air," Report of the Administrator of the Environmental Protection Agency (Washington, D.C.: March 1971), Table 3-4, p. 3-16.

Neither this cost estimate, nor the other cost data cited above, include the additional cost of maintaining such systems, and the increased operating cost (fuel penalty cost). The above cites source estimates these costs to be $20.70 per year.

## Considerations for a Balanced Strategy

The central question for the development of a balanced federal strategy to control auto air pollution is the following: "What is the optimal allocation of federal effort among controlling the source, controlling ownership and usage behavior, and controlling the environment, to achieve some desired level of pollution-free air?" Ideally, to account for uncertainty, measures should be evaluated so as to balance the costs of action against the risks and costs of inaction. This will require knowledge of probabilities -- especially the probabilities of various degrees of control of the source being achieved at various points in time.

It will also require knowledge of the costs and benefits of the policy approaches detailed in this report, and an understanding of the interrelationships between components of the system in which the automobile is imbedded. More precisely, questions such as the following will have to be answered:

1. How significant an impact can new mass transit systems have on displacing automobile usage? What impact can exclusive lanes have on mass transit ridership and car-pool formation?

2. If retrofit of control devices on pre-1968 cars were immediately required, would a pollution-free vehicle be needed in the near future in most states? Would most states need costly emission checking programs?

3. To what extent can urban design and traffic flow control technology increase average speed? Will increases in average speed quickly be offset by greater automotive use?

4. Would it be more efficient to place a charge on emissions and let the normal market mechanisms

# APPENDIX A

## MAJOR FEDERAL AUTO AIR POLLUTION CONTROL LEGISLATION[1]

| Date | Title[2] | Major Provisions |
|---|---|---|
| 1955 | Air Pollution Control Act of 1955 (P.L. 84-159) | Temporary authority for research into all forms of air pollution and possible control methods. |
| 1960 | Schenk Act (P.L. 86-493) | Directed Surgeon General to make a two-year study of the effect of vehicle emissions on public health. (This was made a permanent responsibility of the Surgeon General in 1962, P.L. 87-761.) |
| 1963 | Clean Air Act (P.L. 88-206) | Replaced the 1955 Act and provided for grants (1964-1967) to state and local governments for the establishment and development of air pollution control programs.<br>Directed HEW to develop devices and procedures for motor vehicle pollution control in concert with automotive and fuel industries and other interested parties.<br>HEW was also required to report to Congress semi-annually on progress in abating auto emissions. |
| 1964 | No title (P.L. 88-115) | Required the General Services Administration to set vehicle emission standards similar to the California standards set in 1964, for vehicles it purchased for Federal use. |
| 1965 | Motor Vehicle Air Pollution Control Act (P.L. 89-272)[3] | Authority for HEW to set standards on new motor vehicles. Sample vehicles could be submitted to HEW by manufacturers on a voluntary basis for testing and certification. |

| Date | Title[2] | Major Provisions |
|---|---|---|
| 1967 | Air Quality Act (P.L. 90-148) | Specific authority for research and development on fuels and vehicles (Section 104). |
| | | Authority for HEW registration of fuel additives. |
| | | Exception of California from National auto emissions standards so the state could enforce more stringent standards. |
| | | Federal grants to states for auto emission inspection systems. |
| | | Establishment of a Presidential Air Quality Advisory Board. |
| 1970 | Clean Air Act Amendments of 1970 (P.L. 91-604) | Establishes standards for new motor vehicle emissions for 1975-76. |
| | | Makes certification of new cars a requirement for sale. Also provides authority for revocation of certificates of conformity and assembly line testing of vehicles. |
| | | Authority to regulate fuel additives. |
| | | Authority for increased expenditures for Federal purchase of low emission vehicles. |
| | | Requires manufacturers to warranty pollution control systems. |

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1. For a detailed year by year history of federal automobile air pollution policy, see Donald D. Kummerfeld and Gregory Wilcox, "Federal Policy on Auto Air Pollution Control", Center for Political Research Report, April 13, 1970, Appendix A.

2. Despite differing titles, all legislation after 1963 constituted amendments to the Clean Air Act.

3. The Motor Vehicle Act was Title II of P.L. 89-272. Title I consisted of minor amendments to the 1963 Act and Title III was the Solid Waste Act.

> stimulate the auto manufacturers to produce predominantly low-emission vehicles? Or stimulate motorists to maintain their vehicles better or drive less, especially in critical locations?

In sum, this report should be viewed as a first step in the development of a balanced strategy; it sets forth the range of policy approaches in a meaningful analytic framework. Additional research is needed at this time to obtain precise estimates of the costs and benefits of supplementing existing governmental policy with the measures detailed in the foregoing chapters. Particularly important would be an investigation of the political, legal, and administrative difficulties of implementing such measures. For example:

1. What political obstacles are paramount (e.g., strong resistance to work staggering plans on the part of powerful business interests)?
2. What legal authority (e.g., to require retrofit devices or to establish emission checking programs) is required in addition to existing laws, regulations, licensing systems and so forth?
3. What administrative difficulties can be identified (e.g., impracticable vehicle inspection programs)?

Information as to the air quality improvements realizable under each technique, and their associated costs and implementation difficulties, will be vital for the development and selection of a "preferred" strategy package. Research data and collection must begin shortly if supplementary policies are to be developed soon enough to reduce the costs of clean air, or, perhaps more importantly, to provide a "fail-safe" system to insure that the quality of our air at mid-decade will be in compliance with the standards established to protect public health.

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1. The Institute of Public Administration and TRW, Inc., have recently commenced (August 1, 1971) a six-month project designed to investigage precisely the sorts of questions raised above for the six cities with the most severe carbon monoxide problems. This study is being done for the Office of Land Use Planning, Environmental Protection Agency.

# APPENDIX B

## EXHAUST EMISSION STANDARDS[1]

Following the lead of California, where standards were established for carbon monoxide and hydrocarbon emissions in 1964, the Federal Government established emission standards for these two pollutants for all automobiles sold after January 1, 1968. The standards were tightened for 1970-71 models with the intention of achieving an 80 percent hydrocarbon reduction and a 69 percent reduction in carbon monoxide emissions.[2] These reductions have been realized when exhaust emissions are measured by the current test procedures. However, in July 1970 the existing procedures were revised. Using the newly-developed test procedure, the achieved degree of control was considerably lower than expected -- a 69 percent reduction in hydrocarbons, and a 60 percent reduction in carbon monoxide emissions were actually realized. The 1970-71 standards were modified to provide the intended degree of control, and these revised standards will have to be met by 1972 model cars.

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[1] Exhaust emissions account for approximately 100 percent of the nitrogen oxide emissions, 100 percent of the particulate emission, and 55 percent of the hydrocarbon emissions. The uncontrolled internal combustion engine also emits contaminants from two other locations -- fuel tank and carburetor evaporation (20 percent hydrocarbons), and crankcase blowby (25 percent hydrocarbons). However, complete control over the latter has been achieved and the evaporative losses have been reduced to negligible amounts. Thus the task of the present air pollution policy (as far as the internal combustion engine is concerned) is almost exclusively to reduce exhaust emissions.

[2] Reductions are measured relative to uncontrolled (pre-1968) vehicles.

## Table A

## EXHAUST EMISSION STANDARDS AND UNCONTROLLED VEHICLE EMISSION LEVELS

Former Test Procedure

| | Hydrocarbons | | Carbon Monoxide | | Oxides of Nitrogen | |
|---|---|---|---|---|---|---|
| | G./mi.[1] | Per-cent[2] | G./mi. | Per-cent | G./mi. | Per-cent |
| Baseline (uncontrolled vehicle)* | 11.2 | --- | 73.0 | --- | --- | --- |
| Present standards ,(intended degree of control)* | 2.2 | 80 | 23.0 | 69 | N.A.[3] | N.A. |
| **Revised Test Procedures[4]** | | | | | | |
| Baseline (uncontrolled vehicle)* | 14.6 | --- | 116.3 | --- | 6.0 | --- |
| Equivalent present standards (achieved degree of control)* | 4.6 | 69 | 47.0 | 60 | --- | --- |
| 1972 Standards (control)* | 2.9 | 80 | 37.0 | 69 | --- | --- |
| 1973 Standards (control)** | --- | --- | --- | --- | 3.0 | 50 |
| 1975 Standards (control)** | .41 | --- | 3.4 | --- | 3.0 | --- |
| 1976 Standards (control)** | .41 | --- | 3.4 | --- | .40 | --- |

1. Grams per mile emitted.
2. Percentage reduction from uncontrolled vehicle.
3. No standards applicable.
4. Final regulations have been promulgated for the measurement of hydrocarbons and carbon monoxide in 1975 and nitrogen oxides in 1976. These procedures are being proposed as the procedures to be used for 1973 model year vehicles.

* Source: APCO. Cited in Environmental Quality, First Annual Report of the Council on Environmental Quality; transmitted to the Congress August 1970, p. 77.

** Source: Federal Register, July 2, 1971.

In addition, in February 1970 the Secretary of HEW proposed standards to limit for the first time emissions of nitrogen oxides beginning with 1973 models and emissions of particulate matter beginning with 1975 models. In an unprecedented move, however, Congress established new car exhaust emission standards for 1975-76 into federal law. These standards, embodied in the Clean Air Act Amendments of 1970, will require a 90 percent reduction in emissions as compared to 1971 model vehicles.[1] Table A summarizes both the current and the recently finalized exhaust emission standards.

The air quality implications of the current federal exhaust emission standards and the effects of non-compliance of the production fleet are summarized in information provided to the Senate Subcommittee on Air and Water Pollution by the National Air Pollution Control Administration:

> Given a knowledge of the emission rates for uncontrolled vehicles and for the controlled prototype fleets, plus the predicted growth in number of vehicles, it becomes possible to project the effects of the Federal mobile emission standard program on total national exhaust emissions of hydrocarbons and carbon monoxide. Air quality is a complex function of total emissions; therefore, changes in total emission values may be assumed to be representative of the changes in air quality in large metropolitan regions.
>
> The effect of each phase of the Federal mobile emission control program is illustrated by the curves labeled A in the accompanying figures. Three cases are considered. Figures I and II represent the projected effect of imposition of the 1968 and 1970 exhaust emission standards . . . . The curves labeled "A" thus represent the relative changes in expected air quality, as projected from present and proposed Federal emission standards for exhaust emissions of carbon monoxide and hydrocarbons and from test data on prototype vehicles . . . .

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[1] Note: no standards have been promulgated for particulates.

> For some time, it has been apparent that a discrepancy exists between the average emission rates of the prototype fleet and the average emission rates of the production fleet in the hands of the public. [see pp. 1-17 to 1-20] . . . . The differences between curves A and B represent the effect of noncompliance of the production fleet. The production fleet data indicate that air quality in 1985 will be 25 percent higher in hydrocarbons and 13 percent higher in carbon monoxide than it would have been if there were no discrepancy in emission rates . . . the oxidant levels in 1985 will also be approximately 25 percent higher. This analysis is based on data gathered from 1968 and 1969 model year cars. To the extent that production fleet performance can be made to approximate prototype emissions more closely, in 1970 and later model years, the discrepancies in the projected curves can be reduced.[1]

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1. Hearings Before the Subcommittee on Air and Water Pollution, United States Senate, 91st Congress, Second Session, March 1970, pp. 371-378.

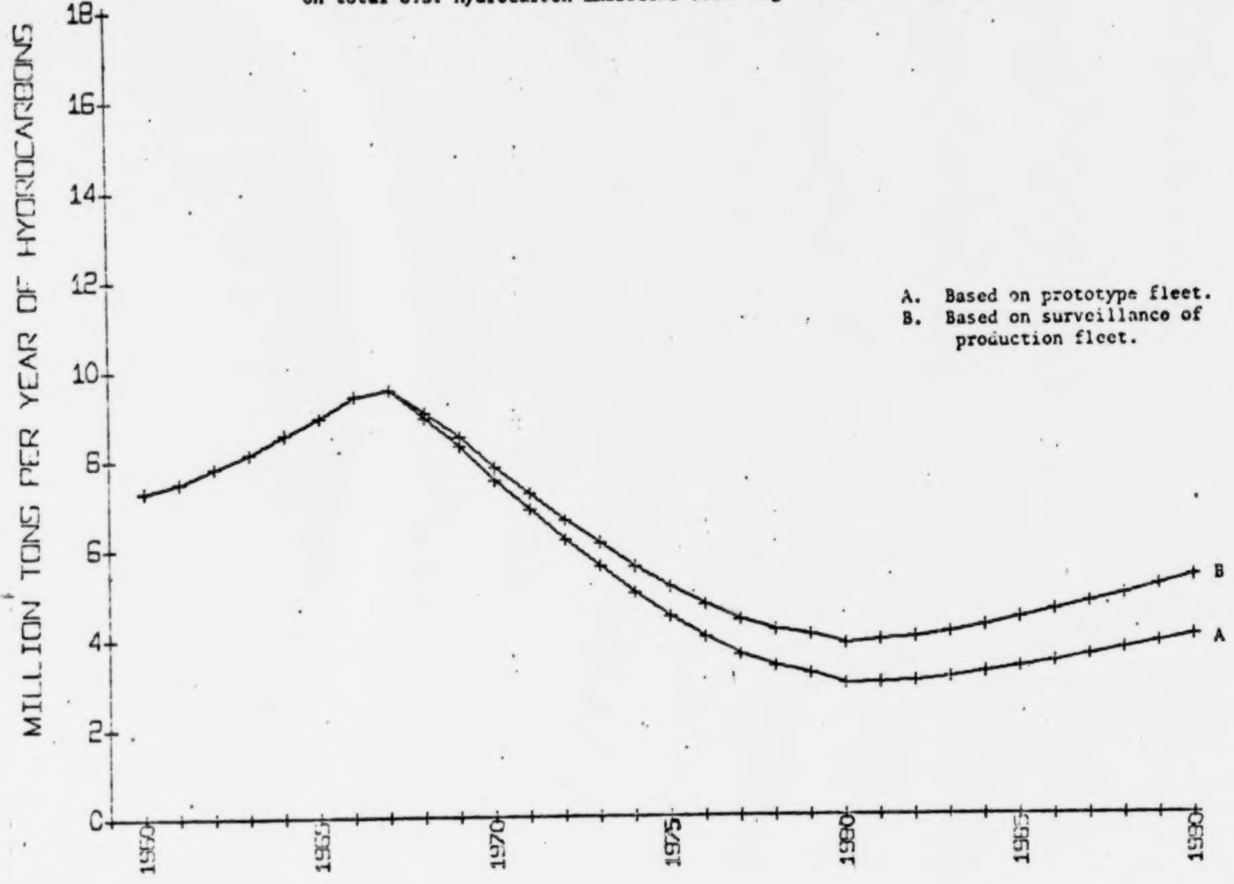

Figure I. Projected effects of 1968 and 1970 Federal Emission Standards on total U.S. Hydrocarbon Emissions from Light Duty Vehicle Exhaust

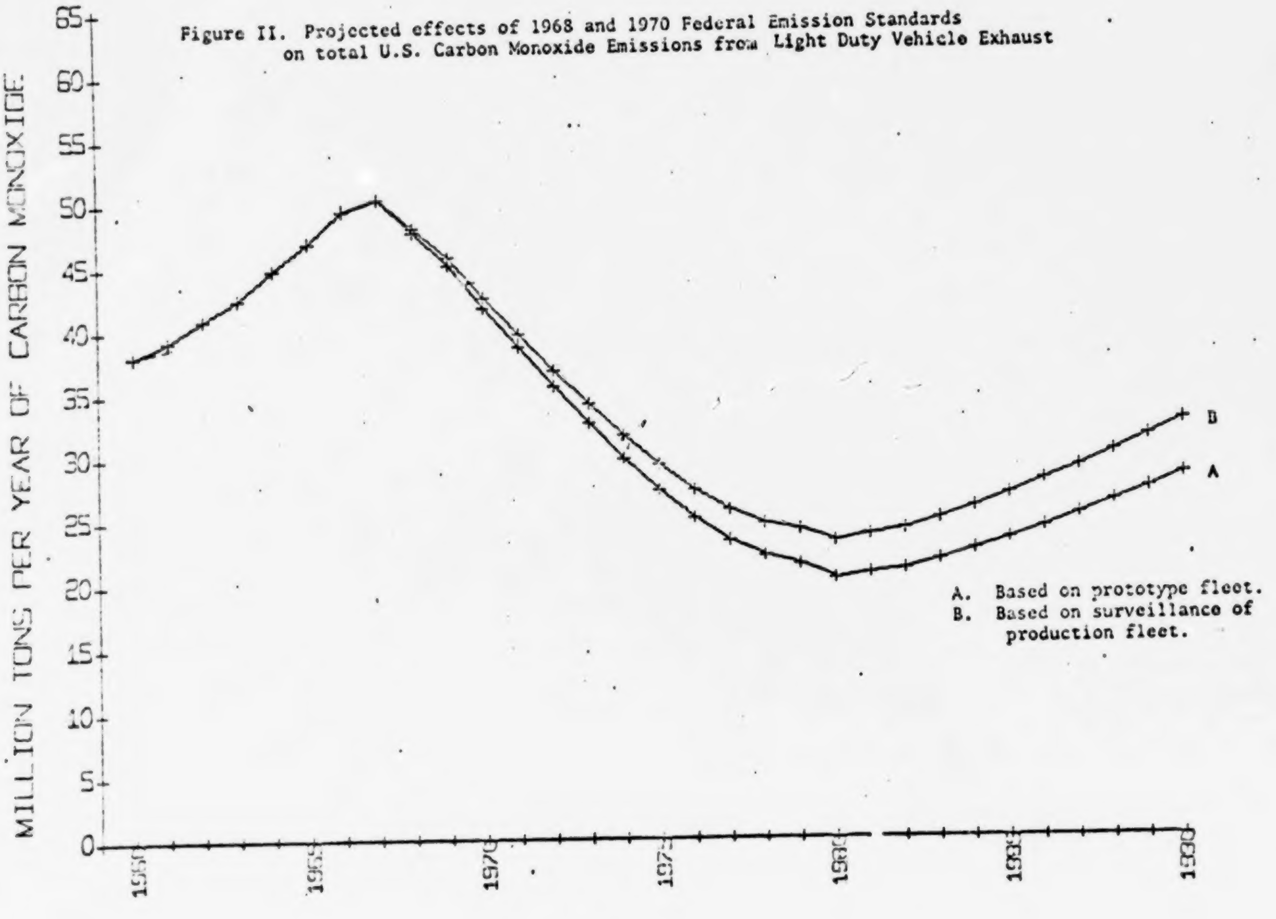

Figure II. Projected effects of 1968 and 1970 Federal Emission Standards on total U.S. Carbon Monoxide Emissions from Light Duty Vehicle Exhaust

The air quality implications of the present and future standards for the three most significant automobile generated air pollutants are depicted in the following diagrams.[1]

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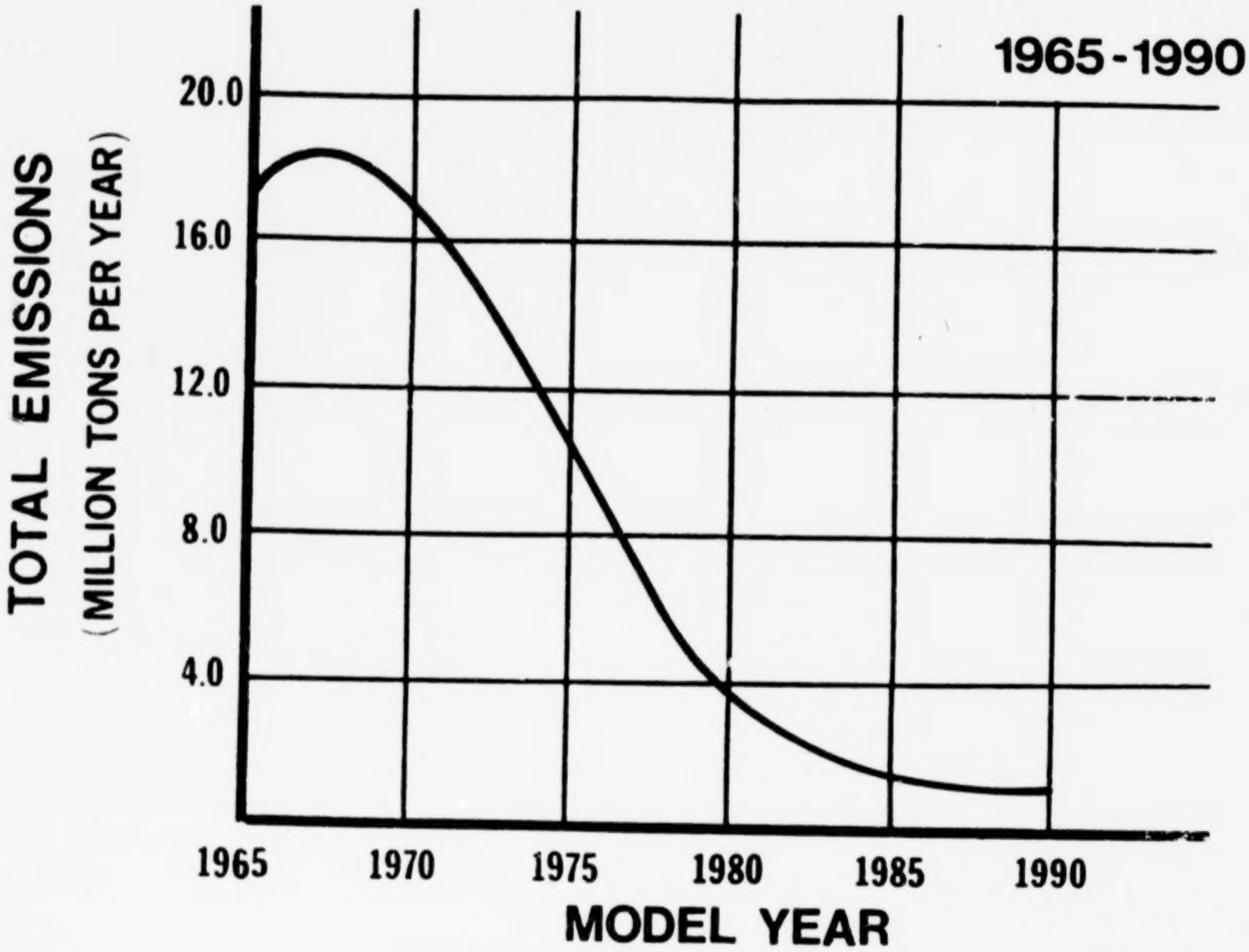
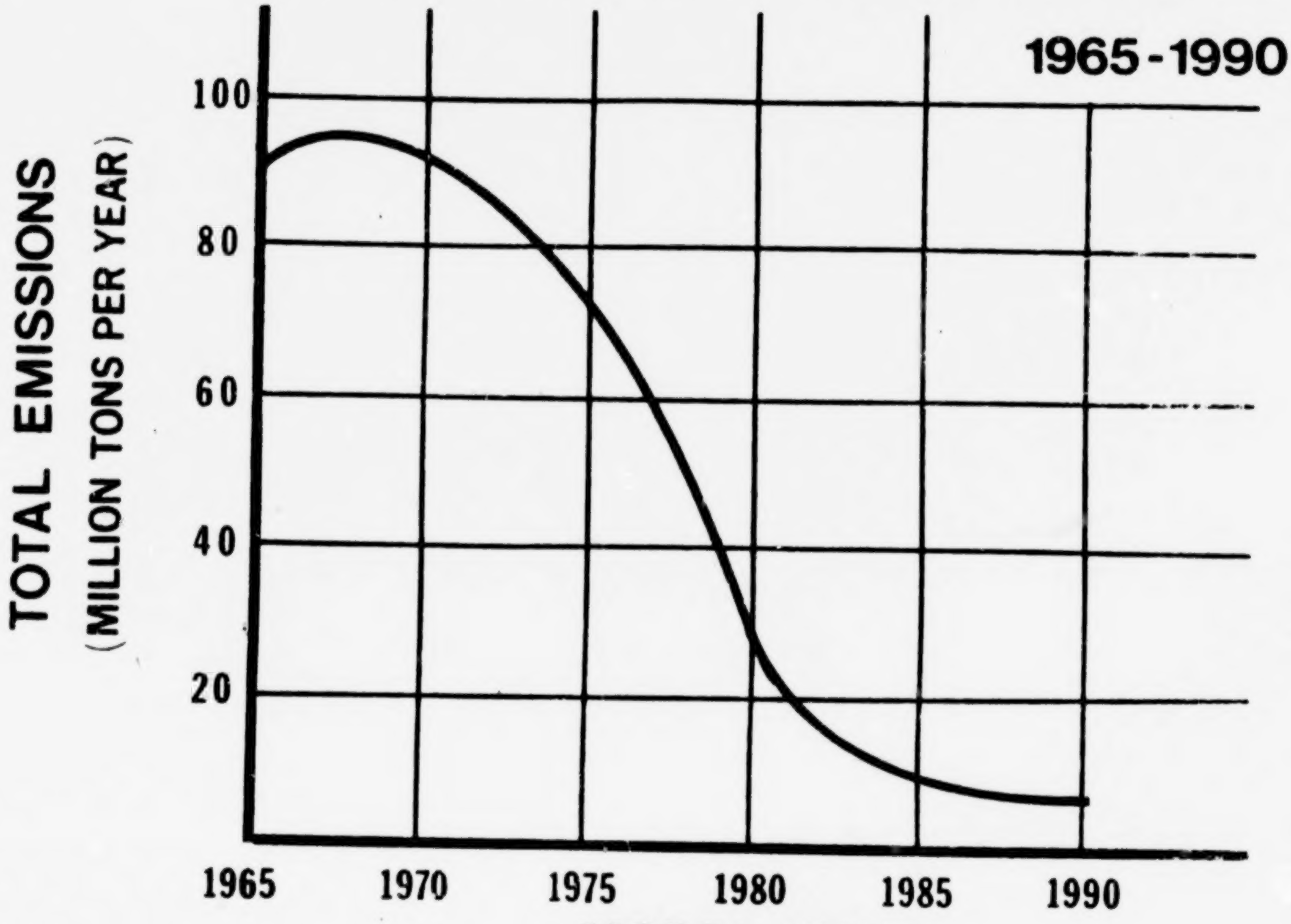
[1] Source: Annual Report of the Environmental Protection Agency to the Congress of the United States in compliance with Section 202(b)(4) Public Law 90-148, pp. 6-8, 6-9, 6-10.

HYDROCARBON EMISSIONS FROM MOTOR VEHICLES IN THE UNITED STATES



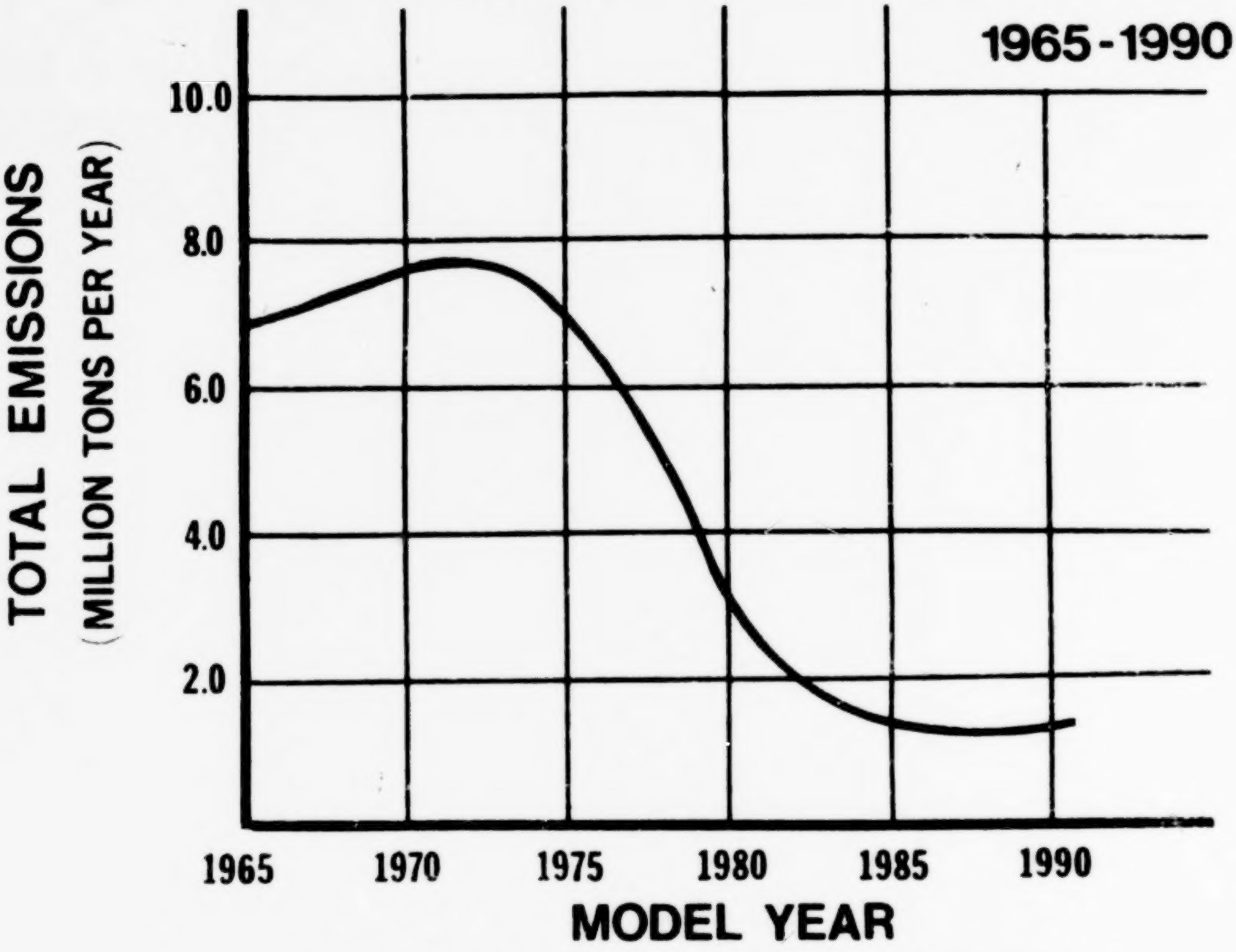
PROJECTIONS BASED ON ACHIEVING ALL FEDERAL EMISSION STANDARDS

CARBON MONOXIDE EMISSIONS FROM MOTOR VEHICLES IN THE UNITED STATES



PROJECTIONS BASED ON ACHIEVING
ALL FEDERAL EMISSION STANDARDS

OXIDES OF NITROGEN EMISSIONS FROM MOTOR VEHICLES IN THE UNITED STATES



PROJECTIONS BASED ON ACHIEVING ALL FEDERAL EMISSION STANDARDS

# APPENDIX C

## RECENT DEVELOPMENTS

Since the initial draft of this document was submitted to the Office of Air Programs on March 1, 1971, a number of significant developments have occurred pertinent to automobile air pollution control. Those relating to the establishment of new exhaust emission standards are incorporated in Appendix B. The following discussion extends the main body of the report from March 1, 1971, through August 1, 1971.

### Compliance with Emission Standards

#### Emission Control Hearings Held[1]

On May 6 and 7, 1971, the Environmental Protection Agency held hearings in Washington to help Administrator Ruckelshaus judge whether automobile manufacturers are making a "good faith" effort to meet motor vehicle standards for 1975 and 1976 models. Under the Clean Air Amendments of 1970, the Administrator may grant a one-year extension of the emission reduction standards if he finds that the manufacturer has made adequate efforts to meet the standards but is still unable to do so. Twenty-one representatives of domestic and foreign automobile manufacturers, related industries, professors, scientists, state governments and public interest groups, along with Administrator Ruckelshaus, testified at the two-day hearings.

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[1] This section draws heavily upon the coverage of this event which appears in CPR Research, Current Actions in Air Pollution Policy, May 1-June 1, 1971.

Probably the most significant testimony came from Mr. Ruckelshaus. He stated that the 1970 Act "does not permit traditional concepts of satisfactory vehicle driving performance to stand in the way of whatever changes in vehicle design and power system are needed to control emissions." He went on to state that "the same is true with regard to vehicle cost." Consequently, the price that must be paid for preserving a healthy environment may be a more expensive car that cannot deliver the road performance of today's high-emission vehicles.

More important was the EPA policy toward suspension of the effective date of reduced standards. Ruckelshaus said that it was his present judgment that if even one manufacturer was able to comply with the standards by the deadline date, then no others would be issued extensions. This hard-line stance is indicative of the EPA assessment that uncontrolled automobile emissions are a major threat to the public health and that, of the six pollutants for which ambient standards have been set (hydrocarbons, photochemical oxideants, sulfur oxides, oxides of nitrogen, particulate matter and carbon monoxide), only sulfur oxides and particulate matter can be effectively controlled without auto-emission reductions.

The testimony from the automobile industry ranged from extreme pessimism about reaching the reduction deadline expressed by American Motors ("there is virtually no possibility") to more optimistic statements made by Ford and other manufacturers. For the most part, chances of meeting the hydrocarbon and carbon monoxide standards in time were considered possible, while oxides of nitrogen requirements seem unreachable at present.

In the annual report to the Congress required by the Clean Air Act Amendments of 1970,[1] the Environmental Protection Agency noted the concern of the manufacturers, but stated it was "moderately optimistic" the standards could be met.

## Exchange of Technical Information

As discussed in Chapter 1 (see pp. 1-30 to 1-32), there has been a continuing debate over the amount and kind of information exchange desirable to foster progress in the development of new technology -- and that amount which might serve to lessen competition. In the past several months, various representatives of the auto industry (including organized labor) and some federal legislators have repeated their contentions that progress in emission control technology is best achieved through unrestricted information sharing. However, in the recently released report to the Congress mentioned above, the Environmental Protection Agency announced that it agrees, in general, with the Department of Justice, that progress in automobile emission control is best assured through primary reliance on competition and independence in research and development efforts conducted by manufacturers.

## Incentives to Low-Emission Vehicle Development

Federal Clean Car Incentive Program. This program is designed to foster private development of new types of low emission vehicles related to the 1975 and 1976 emission standards (see p. 1-41).

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1. P.L. 90-148, Section 202(b)(4).

Since its inception in January 1971, with approximately 20 initial proposals from industry, ten different vehicle systems have been accepted into the program for further consideration. In May 1971, three contracts were approved to provide prototype cars for testing. The Incentive Program is expected to provide valuable information about the feasibility of reaching the 1975-76 emission standards.

## Low-Emission Vehicles Purchase Program

Section 212 of the Clean Air Act provides for the creation of a Low-Emission Vehicle Certification Board (See pp. 1-42, 1-43). EPA initially certifies vehicles which discharge significantly less pollutants than required by current federal regulations. The Board identifies the class of vehicle for which the selected cars are considered suitable substitutes taking into consideration factors such as performance and cost of maintenance. Certified vehicles may be purchased for use in government fleets at premiums of up to 100 percent over the prices normally paid by the government for equivalent vehicles. The non-statutory members of the Board have been named by the President and its first meeting was held on June 18, 1971. At that time the board adopted initial procedural regulations.

# Fuel Policy

## Regulation of Lead Additives

The major tactic in the federal strategy to control atmospheric lead levels will be the regulation of the lead content of motor fuels. At the same time, such regulation will permit the development of the broadest possible range of control technology -- since some promising emission control devices (e.g., catalytic mufflers) can be deactivated to great extent by use of a leaded gasoline.

In the January 30, 1971, Federal Register, the EPA Administrator published his intent to promulgate regulations to control lead additives to motor fuels. The Office of Air Programs intends to require the general availability by July 1974 of lead-free gasoline of an octane quality suitable for 1975 and subsequent model year automobiles. OAP also announced it is in the process of developing a schedule to reduce the lead content of current "regular" and "premium" grades of gasoline from present levels of approximately 2.5 grams per gallon to no more than 0.5 grams per gallon. It is intended that the schedule now under development require lead additives to gasoline be phased out as quickly as is technologically possible.

EPA is now considering the (statutorily required) available scientific, medical and economic data prior to publishing proposed regulations on lead additives.

## Lead Additive Tax

In February 1971, the Administration announced its intention to submit again legislation calling for a tax on lead additives in gasoline. A bill with this intent was killed in Committee during the 91st Congress (see p. 1-49). On the basis of the old legislation, the Treasury Department in cooperation with EPA is writing a new bill incorporating the findings of new studies and conferences with affected industries. The legislation is expected to be submitted during the next session of Congress.

## Transportation Controls

As detailed in Chapter 6, there has been increasing concern with the development of transportation control techniques (e.g., car pool incentives, work staggering) to supplement ongoing efforts to reduce emissions by technological redesign of the source (engine-fuel system). Transportation control plans are, of course, required to be part of the air quality implementation plans which states must submit to EPA by January 30, 1972.

It is clear that EPA expects localities with severe air pollution problems to incorporate stringent transportation controls in their implementation plans. An example is the suggestion of Dr. John T. Middleton that Los Angeles might include staggered work hours, provision for a four-day work week, abolition of gasoline as a fuel, and a mandatory requirement for mass transit in some areas.[1] He also said that the Federal Government would write an air pollution control plan for California if state and local governments fail to plan to meet national air quality standards.

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1. John T. Middleton, Address to Los Angeles County Environmental Control Committee, June 21, 1971.